UNITED STATES
DEPARTMENT OF THE INTERIOR

# FINAL ENVIRONMENTAL STATEMENT

## Volume I of 3

Proposed
1976 OUTER CONTINENTAL SHELF
OIL AND GAS GENERAL LEASE SALE
GULF OF MEXICO

## OCS SALE No. 41

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

Prepared by the
BUREAU OF LAND MANAGEMENT

Curt Berklund

Director

Final Environmental Statement for the Proposed 1976 Outer Continental Shelf Oil and Gas General Lease Sale - Gulf of Mexico - OCS Sale No. 41

Addendum

Page ii - 7. Final statement made available to Council on Environmental Quality and the public on December 12, 1975.

Page 443. First paragraph - The U. S. Geological Survey is currently revising OCS Orders 1 thru 12, governing Oil, Gas, and Sulphur Leases in the Outer Continental Shelf - Gulf of Mexico Area. The effluent limitations pertaining to waste water disposal systems (OCS Order No. 8) will be revised to state that effluent limitations will conform to the applicable EPA regulations, as published in the Federal Register on September 15, 1975 (40 CFR 435). The appropriate information is presented in the Development Document for Interim Final Effluent Limitations Guidelines and New Source Performance Standards for the Offshore Segment of the Oil and Gas Extraction Point Source Category: EPA(440/1-75/055).

Summary: OCS Sale No. 41

( ) Draft (X) Final Environmental Statement
Department of the Interior, Bureau of Land Management, Gulf of Mexico OCS Office

1. Proposed Oil and Gas Lease Sale, Outer Continental Shelf Gulf of Mexico
   (X) Administrative ( ) Legislative Action

2. One hundred and thirty-five tracts (698,077 acres) of OCS land are proposed for leasing action. The tracts are located offshore Texas, Louisiana, Mississippi, Alabama and Florida. If implemented, this sale is tentatively scheduled to be held in the spring of 1976.

3. All tracts offered pose some degree of pollution risk to the environment. The risk potential is related to adverse effects on the environment and other resource uses which may result principally from accidental or chronic oil spillage. Each tract offered is subjected to a proximity evaluation technique in order to evaluate significant environmental impacts should leasing and subsequent oil and gas exploration and production ensue.

4. Alternatives to the proposed action:

   A. Hold the Sale in Modified Form
      1. Sale Modification Alternatives
         a. Delete tracts
         b. Substitute tracts

   B. Withdraw the Sale
      1. Energy Conservation
      2. Conventional Oil and Gas Supplies
      3. Coal
      4. Nuclear Power
      5. Oil Shale
      6. Hydroelectric Power
      7. Solar Energy
      8. Energy Imports
      9. Geothermal Energy
      10. Other Energy Sources
      11. Combination of Alternatives

   C. Delay the Sale

   D. Alternative With the Proposed Action; Government Exploratory Drilling Before Leasing

5. Comments have been requested from the following:

* Environmental Protection Agency

* Department of Commerce
    National Oceanic and Atmospheric Administration

* Department of Defense

Department of Transportation
    U. S. Coast Guard

Federal Energy Administration

* Energy Research and Development Administration

Federal Power Commission

* State of Texas
    Division of Planning Coordination

* State of Louisiana
    Office of State Planning

* State of Mississippi
    Coordinator, Federal-State Programs

* State of Alabama
    Director of State Planning

* State of Florida
    Department of Administration

Department of the Interior
    * U. S. Fish and Wildlife Service
    * Bureau of Outdoor Recreation
    * Bureau of Mines
    * Geological Survey
    * National Park Service

6. Draft Statement made available to Council on Environmental Quality and the public on August 20, 1975.

7. Final statement made available to Council on Environmental Quality and the public on December

* Comments received

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# I. DESCRIPTION OF PROPOSAL

## A. Location and Reserves

The sale under consideration includes 135 tracts offshore Texas, Louisiana, Mississippi, Alabama and Florida. Tracts are summarized by water depth, distance from shore, and expected type of production in Appendix A. These tracts, if leased, would add 698,077 acres, an increase of about 8.5% to the current total of 8.2 million acres (as of August 14, 1975) under federal lease in the Gulf of Mexico. Sixteen tracts encompassing approximately 61,352 acres are drainage and development tracts. The remaining 119 tracts are wildcat. The tracts in this proposed sale range from six meters to 200 meters in water depth and from four to 127 miles from shore (Graphic 1, Vol. 3). One tract is located in water depth of 200 meters or more. Thirty-seven percent of the tracts offered are gas prone, three percent are oil prone, and sixty percent are oil and gas prone. The proposed lease sale would be made under Section 8 of the Outer Continental Shelf Lands Act (76 Stat. 462; U.S.C. Sec. 1337) and regulations issued under that statute.

The estimated undiscovered recoverable reserves which could be developed as a result of this sale amount to 100 to 300 million barrels of oil and two to four trillion cubic feet of gas. This would require an estimated 150 to 400 wells from 20 to 50 platforms and require 50 to 100 miles of pipelines. It is estimated that the proposed leases may produce 35,000 to 120,000 barrels of oil per day and 0.5 to 1.1 billion

cubic feet of gas per day after development and production stabilizes. After consulting with industry representatives and the U. S. Geological Survey, it is not anticipated at this time, that any barging of production from offshore sites to onshore receiving facilities will occur as a result of this proposed sale.

B. Legal and Administrative Background

In 1953, the Outer Continental Shelf (OCS) Lands Act (67 Stat. 462) established Federal jurisdiction over the submerged lands of the continental shelf seaward of the state boundaries. The Act charged the Secretary of the Interior with the responsibility for the administration of the mineral exploration and development on the OCS. It also empowered the Secretary to formulate regulations so that the provisions of the Act might be met.

Subsequent to the passage of the OCS Lands Act of 1953, the Secretary of the Interior designated the Bureau of Land Management (BLM) as the administrative agency for leasing submerged federal lands, and the U. S. Geological Survey (USGS) for supervising operations. The Department formulated three major goals for the comprehensive management program for marine minerals. These are:

(1) The orderly development of the marine mineral resources to meet the energy demands of the nation.

(2) The protection of the marine and coastal environment.

(3) The receipt of a fair return for the leased mineral resources.

These leasing objectives are based on legislative mandates as explained

below.

(1) Orderly resource development is based on the OCS Lands Act which gives the Secretary the authority, in order to meet the urgent demand for oil and gas, to grant leases to the highest qualified bidder(s) on the basis of sealed competitive bids.

(2) Protection of the marine and coastal environment is a direct outgrowth of the National Environmental Policy Act of 1969. This act requires that all federal agencies shall utilize a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences in any planning and decision-making which may have an impact on man's environment. The products of BLM efforts in this direction are Environmental Impact Statements (EIS), Environmental Assessment Teams and contract studies designed to identify and characterize different types of environments and the problems that they face.

(3) Receipt of fair market value has basis in two separate mandates. United States Code 31, Sec. 483 (a) obligates the Federal Government to obtain a fair return for public lands that are sold or leased. This is further implemented within the Executive Branch by Bureau of the Budget Circular A-25.

### C. Tract Selection Process

The tract selection process is one of the steps used by the department in attaining its objectives of orderly resource development, protection of the environment and receipt of fair market value.

The first step in this process involves an identification, by the Department of the Interior, of a broad potential lease area offshore in the Gulf of Mexico. In December 1974, a Call for Nominations requested industry to nominate by tracts, areas they would like to see offered for lease, most tracts are three square miles or 5,760 acres. The call also solicits redommendations concerning tract withdrawals for environmental or other reasons. The nominated areas were then evaluated by both BLM and USGS to make an initial determination of selected tracts to offer in the event of a sale. The nominated areas were evaluated on the bases of

(1) Interest shown (nominations)

(2) Geology and potential reserves

(3) Environmental as well as other considerations

1. Nominations and Leasing History

The Department's call for nominations in the Gulf of Mexico resulted in approximately 11.5 million acres (2,098 tracts) being nominated by 29 companies. During the tract selection process the 11.5 million acres was reduced to approximately 0.697 million acres (134 tracts). Interest shown as determined by the number of nominations received by each tract was an important factor in the tract selection process.

2. Geology

In February 1975, the Bureau of Land Management in New

Orleans requested preliminary geological and geophysical data from USGS and subsequently received this information. In March,1975 BLM requested a geologic and geophysical evaluation by USGS of each prospective tract. This evaluation was completed and the review by USGS covered the following:

(1) Resource estimates
(2) Geological information
(3) Geophysical data
(4) Actions planned to fill data gaps
(5) Deep water technology
(6) Problems associated with exploration and development
(7) Availability of material, equipment, personnel and capital
(8) Drainage of adjacent state lands

In the great majority of cases the USGS data confirmed the recommendations as determined by the initial analysis of nominations.

3. Environmental Considerations

Responsibility for the initial selection of tracts lies with the New Orleans office of the Bureau of Land Management and the U. S. Geological Survey under guidance as to Departmental policy and objectives furnished by the respective Washington offices.

BLM and USGS also consider recommendations by the U. S. Fish and Wildlife Service regarding permits for exploration and minerals development.

Specifically, the tract selection process included a detailed analysis of all areas where possible environmental degradation might occur as a result of oil exploration and development. The environmental

resource categories receiving evaluation included:

(1) Geology (bottom sediments and paleontology)
(2) General climatology and seasonal weather patterns (visibility, winds, temperature, inversions, storms and precipitation)
(3) Physical oceanography (sea temperatures, salinity, surface circulation including currents, waves, swells and tides)
(4) On and offshore outdoor recreation
(5) Archaeological and historical sites
(6) Land use
(7) Socio-economics (population, employment, income, economic characteristics, agriculture, refining and processing facilities)
(8) Transportation network
(9) Air and water quality
(10) Physical hazards (ocean dumping areas, military activities, existing pollution factors, undersea cables, ship transit lanes, shipwrecks and harbor areas)
(11) Terrestrial soils and vegetation
(12) Phytoplankton
(13) Benthos
(14) Intertidal and reef communities
(15) Endangered species
(16) Areas of unique biological significance and marine life preserves
(17) Terrestrial birds and wildlife
(18) Marine birds and mammals
(19) Commercial and sport shellfish
(20) Finfish, including commercial and sport finfish areas
(21) Beach and shoreline areas
(22) Aesthetics

The above basic information was then interpreted (using both written documentation and map overlays) in regards to the potential impact on, or hazard to, the individual resource from offshore drilling and development, pipeline construction and oil spillage. From these interpretations "potential environmental hazard zones" were developed for use in the tract selection process. This type of procedure was also used in evaluating other considerations as well.

4. Other Considerations

Other areas which were researched and evaluated as part of the tract selection process were:

(1) Use conflicts (defense warning zones, etc.)
(2) Policy guidelines
(3) Possible drainage of reserves from state lands

D. Activity Resulting from this Proposal in the Gulf of Mexico

The amount of commercial activity that may be generated in the Gulf of Mexico region as a result of this proposal is dependent on many variables. Chief among them would be the availability of capital, manpower, equipment and the amount of proven recoverable resource. Table 1 summarizes the range of activity and reserves that may reasonably be expected to occur if the proposed sale is held.

Table 1. Summary of the Range of Activities Required to Develop the Estimated Reserves Within the Proposed Lease Sale Tracts

1. Estimated Acreage, Construction Activity and Reserves

| | This Proposed Sale |
|---|---|
| a. Acres (millions) | .244 1/ |
| b. Wells | 150 - 400 |
| c. Platforms | 20 - 50 |
| d. Miles of pipelines | 50 - 100 |
| e. Terminal storage facilities | 0 - 2 |
| f. Reserves | |
| - Oil (million bbl.) | 100 - 300 |
| - Gas (trillion cu. ft.) | 2 - 4 |

1/ Estimated that 35% of the acreage proposed for offering in this sale will lease.

Table 1. Continued.

2. Estimated Annual Crude Oil Transportation

   Transported by tankers 0 barrels per year

   Transported by pipeline

   | | |
   |---|---|
   | Minimum estimate | 21.9 million barrels/year |
   | Maximum estimate | 27.4 million barrels/year |

3. Estimated Volume of Commercial Mud and Drill Cuttings

   Assume 400 wells with average depth of 10,000 feet

   Cuttings: 682 tons per well; Mud components: 230 tons per well, assume 10% consumed during drilling, balance reused in other wells.

   | | |
   |---|---|
   | Drill Cuttings | 272.8 thousand tons |
   | Mud Components | 9.2 thousand tons |

4. Estimated Volume of Produced Formation Water Proposed Lease Sale Area

   Assume 0.6 barrels formation water produced for each barrel of oil and condensate

   Annual production = 13.1 to 16.4 million barrels/year

   Total production = 60 to 180 million barrels

5. Estimated Total Land Use Requirements for Onshore Facilities

   0 - 80 acres

6. Estimated Pipeline Burial Disturbance

   Offshore = (where burial required) 4,000 - 8,000 cubic yards/mile

   Onshore = A zone 30 - 40 feet wide along pipeline right-of-way

E. Relationship of this Proposed Action to Existing and Prospective Offshore Oil and Gas Development in the Gulf of Mexico

This proposed action must be viewed as one part of a continuing activity that has been underway since the 1940's. Although primary emphasis concerning the description of the proposal and its potential environmental effects has been placed on this particular sale in isolation from all previous activities of the same nature, it should also be put into a perspective of an on-going offshore oil and gas development process. As of July 29, 1975, there have been 31 OCS oil and gas (and five OCS sulfur and salt) lease sales on submerged lands in federal areas of the Gulf of Mexico.

Total Acreage Leased in Gulf of Mexico from the Inception of OCS Leasing Activities Through August 14, 1975

| Area | Acreage |
|---|---|
| Louisiana | 8,286,563 |
| Texas | 3,106,146 |
| Miss., Ala., Florida | 485,397 |
| Total | 11,878,016 |

Acreage Currently Under Lease in Gulf of Mexico as of August 14, 1975

| Area | Acreage |
|---|---|
| Louisiana | 5,670,586 |
| Texas | 2,076,413 |
| Miss., Ala., Florida | 485,397 |
| Total | 8,232,396 |

The Geological Survey has issued a total of 830 pipeline permits on the OCS resulting in 2,228 miles of offshore pipelines. Currently, the Bureau of Land Management holds 374 permits on the OCS resulting in 4,736 miles of offshore pipelines.

As production declines in existing areas, much of the equipment, transportation facilities, pipeline, platforms, etc., not to mention the personnel and technological expertise presently available, can be used for new areas of activity. As existing areas of production declines, the pipelines in place for that system can be used for new production areas, adjacent or further from shore, reducing the quantity of pipelines necessary to transport production from new areas to shore. This latter event has already been exercised in some areas offshore Louisiana. Likewise, a reduction in quantity of onshore facilities, such as treatment plants, refineries, storage facilities, etc., is made possible by utilizing existing facilities, equipment and technology.

F. Development of Proposed OCS Planning Schedules for Potential OCS Oil and Gas Leasing and the Department's Proposed Program to Accelerate OCS Oil and Gas Leasing Nationwide

Proposed OCS planning schedules are developed in order to project the timing, size and location of specific lease sales for an OCS leasing program. General sale areas are identified and, at a later date, tentative acreage figures are set for each proposed sale on the basis of broad resource knowledge. The goal of the proposed schedule is to provide for orderly development of OCS oil and gas resources and to maintain an adequate contribution of OCS production to the national supply.

In developing a proposed OCS planning schedule, the Department considers the three leasing objectives that have been set for a Departmental OCS program. These objectives are: 1) orderly and timely resource development; 2) protection of the environment; 3) receipt of fair market value. The overriding factor in planning for OCS leasing is to strive for a supply of oil and natural gas adequate to meet the demand for these resources, consistent with the protection of environmental values. This is the foundation of and justification for the existence of any OCS leasing program. The tentative acreage selection process that follows must consider the need to balance supply with demand. Acreage is tentatively selected in sufficient amount to engender industry interest and promote a fair market return.

The proposed OCS planning schedule is essential as a program planning document to enable the Department to proceed in an orderly and timely fashion with its process of considering the several proposed and possible lease sales identified in that document. The proposed OCS planning schedule aids Interior in establishing the order in which areas will be examined and in planning the work assignments of personnel and the allocation of resources for the environmental and other studies enumerated. The proposed OCS planning schedule also serves to apprise federal, state, and local agencies, industry, and interested members of the public of the time frame for consideration of potential leasing in the identified areas of the OCS. The proposed OCS planning schedule is a flexible document that is subject to revision at any time. More particularly, the consideration of any proposed or possible sale is

subject to being terminated, modified, deferred, or advanced.

In May 1974, the Department announced that it would prepare a draft environmental impact statement on the proposed program to accelerate OCS oil and gas leasing from three to ten million acres in 1975. This proposal considers the entire United States' Outer Continental Shelf. A draft environmental impact statement on this proposed program was published in October, 1974, submitted to CEQ and made available to the public for review and comment. Public hearings were held in February, 1975, on the draft statement in Anchorage, Alaska; Beverly Hills, California; and Trenton, New Jersey.

In November, 1974, the Department modified the goal of its proposed accelerated OCS oil and gas leasing program nationwide from leasing 10 million acres in 1975, to holding six proposed lease sales 1/ in 1975 and six possible lease sales 2/ per year for the period 1976 through 1978, offering prospects in each frontier area 3/ by the end of 1978. Accelerated leasing remains an integral part of the proposal, but the specific acreage figure has been eliminated.

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1/ A proposed sale, as used herein, refers to a tentative sale as to which tract selections have been made for the purpose of preparing a site-specific environmental impact statement.

2/ A possible sale, as used herein, refers to a tentative sale which has been listed on a proposed planning schedule, but has not reached the tract selection stage of the consideration process.

3/ Frontier areas refers to any of the 17 recognized OCS areas in which there has been no prior Federal oil and gas leasing.

On November 14, 1974, a new proposed OCS planning schedule was announced by the Department of the Interior at a conference with coastal States' Governors. The proposed sale under consideration herein is listed as the seventh sale on that proposed schedule. The 1974 proposed schedule replaced an earlier five year schedule that had been issued in July, 1973.

The proposed OCS planning schedule, issued in November, 1974, was revised in June, 1975, (Figure 1) to reflect changes in the timetables for considering certain sales listed on that schedule.

Some of the major resource, environmental and technological factors weighed in developing the proposed OCS planning schedule issued in November 1974, are as follows:

1. Review of the Council on Environmental Quality's environmental reports concerning the Gulf of Alaska and Atlantic OCS, and consideration of their ranking of areas by environmental risk and their concern for adequate regulation and utilization of technology. The Department has recently responded to this report, outlining the steps being taken on the basis of CEQ's recommendations.

2. Review of the results of Interior's survey of industry, state, and local governments, and interested members of the public concerning resource potential, leasing preferences, and matters of environmental concern. These results were published in June, 1974.

3. Collection and examination of considerable amount of resource data gathered in seismic surveys of these areas.

Figure 1.

## PROPOSED OCS PLANNING SCHEDULE

JUNE 1975
(REVISES NOVEMBER 1974 SCHEDULE)

| SALE AREA | | 1974 | | | | | | 1975 | | | | | | | | | | | | 1976 | | | | | | | | | | | | 1977 | | | | | | | | | | | | 1978 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | D |
| SOUTH TEXAS | 37 | | DES | PH | | BSI FES | | N | Sale | | | | | S | A | L | E | | H | E | L | D | | I | N | | F | E | B | R | U | A | R | Y | | 1 | 9 | 7 | 5 | | | | | | | | | | | | | | | | | | |
| CENTRAL GULF | 38 | ND | | | T | | DES | PH | | FES | N | Sale | | | | | | | S | A | L | E | | H | E | L | D | | I | N | | M | A | Y | | 1 | 9 | 7 | 5 | | | | | | | | | | | | | | | | | | |
| CENTRAL GULF | 38A | ND | | | T | | DES | PH | | FES | N | | | Sale | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| SOUTHERN CALIF. | 35 | | T | | | | | | DES | | | PH | BSI | | FES | N | Sale | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COOK INLET | 1/ | F | E | D | E | R | A | L | | – | | S | T | A | T | E | | S | A | L | E | | – | | D | A | T | E | | U | N | C | E | R | T | A | I | N | | | | | | | | | | | | | | | | | |
| GULF OF ALASKA | 39 | BSI | | | | C | ND | | | T | | | DES | | PH | | FES | N | Sale | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| GULF OF MEXICO (GENERAL) | 41 | | | | | | C | ND | | T | | | | DES | | PH | | | FES | N | Sale | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MID--ATLANTIC | 40 | | | | | | | | | C | | | BSI ND | | T | | DES | | PH | | | FES | N | Sale | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| NORTH ATLANTIC | 42 | | | | | | | | | | | | C | | ND | BSI | T | | | DES | | PH | | | FES | N | Sale | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| GULF OF MEXICO (DRAINAGE) | 44 | | | | | | | | | | | | | | | | | | T | | | DES | | PH | | | FES | N | Sale | | | | | | | | | | | | | | | | | | | | | | | | | | |
| SOUTH ATLANTIC | 43 | | | | | | | | | | | | | C | | | BSI ND | | | T | | | DES | | PH | | | FES | N | Sale | | | | | | | | | | | | | | | | | | | | | | | | | |
| GULF OF ALASKA (INCLUDING KODIAK) | 46 | | | | | | | | | | | | | BSI | | | C | | ND | | T | | | DES | | PH | | | FES | N | Sale | | | | | | | | | | | | | | | | | | | | | | | | |
| BERING SEA (ST. GEORGE) | 45 | | | | | | C | ND | | | | BSI | | T | | | | | | | | | | | | | DES | | PH | | | FES | N | Sale | | | | | | | | | | | | | | | | | | | | | |
| GULF OF MEXICO (DEEP) | 47 | | | | | | | | | | | | | | | | | | | C | | ND | | | T | | | DES | | PH | | | FES | N | Sale | | | | | | | | | | | | | | | | | | | | |
| SO. CALIFORNIA | 48 | | | | | | | | | | | | | | | | | | | | | C | | ND | | | T | | | DES | | PH | | | FES | N | Sale | | | | | | | | | | | | | | | | | | |
| MID–ATLANTIC | 49 | | | | | | | | | | | | | | | | | BSI | | | | | | C | | ND | | | T | | | DES | | PH | | | FES | N | Sale | | | | | | | | | | | | | | | | |
| BEAUFORT SEA | 50 | | | | | | | | | | | BSI | | | | | | | | | | | | | | C | | ND | | | T | | | DES | | PH | | | FES | N | Sale | | | | | | | | | | | | | | |
| OUTER BRISTOL BASIN | 51 | | | | | | | | | | | BSI | | | | | | | | | | | | | | | | C | | ND | | | T | | | DES | | PH | | | FES | N | Sale | | | | | | | | | | | | |
| NORTH ATLANTIC | 52 | | | | | | | | | | | | | | | BSI | | | | | | | | | | | | | | C | | ND | | | T | | | DES | | PH | | | FES | N | Sale | | | | | | | | | | |
| CALIFORNIA GENERAL INCL. WASH. & OREGON | 53 | | | | | | | | | | | | | | | | | | | | | | | | | | BSI | | | | | C | | ND | | | T | | | DES | | PH | | | FES | N | Sale | | | | | | | | |
| SOUTH ATLANTIC (BLAKE PLATEAU) | 54 | | | | | | | | | | | | | | | | | | | BSI | | | | | | | | | | | | | | C | | ND | | | T | | | DES | | PH | | | FES | N | Sale | | | | | | |
| BERING SEA (NORTON BASIN) | 55 | | | | | | | | | | | | | | | | | | | | | BSI | | | | | | | | | | | | | | C | | ND | | | T | | | DES | | PH | | | FES | N | Sale | | | | |
| GULF OF ALASKA – ALEUTIAN SHELF | 56 | | | | | | | | | | | | | BSI | | | | | | | | | | | | | | | | | | | | | | | | C | | ND | | | T | | | DES | | PH | | | FES | N | Sale | | |
| CHUKCHI SEA HOPE BASIN | 57 | | | | | | | | | | | | | | | | | | | | | | | | | BSI | | | | | | | | | | | | | | C | | ND | | | T | | | DES | | PH | | | FES | N | Sale |

BSI Baseline Studies Initiated
C Call for Nominations
ND Nominations Due
T Announcement of Tracts
DES Draft Environmental Statement
PH Public Hearing
FES Final Environmental Statement
N Notice of Sale
1/ State May Conduct Sale

Baseline studies scheduled are contingent upon scientific personnel and equipment being available to perform the studies.
Sales are contigent upon technology being available for exploration and development. A decision whether to hold any of the lease sales listed will not be made until completion of all necessary studies of the environmental impact and the holding of public hearings; as a result of the environmental, technical, and economic studies employed in the decision – making process, a decision, may, in fact, be made not to hold any sale on this schedule.

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

U.S. DEPARTMENT OF THE INTERIOR
March 3 1849

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This proposed OCS planning schedule does not represent a decision to lease in any of these particular areas. It represents only the Department's intent to consider leasing in such areas and to proceed with the leasing development of such areas if it should be determined that leasing and development in such areas would be environmentally, technically and economically acceptable. Thus, the modification program proposal to accelerate OCS oil and gas leasing entails leasing of some of all frontier areas by the end of 1978.

The Department has revised the content of the draft programmatic environmental impact statement in light of the written comments received on that statement and oral comments submitted at the public hearings held in February, 1975. The final OCS programmatic EIS addresses the proposed program as modified in November, 1974, and includes a discussion and analysis of the proposed OCS planning schedule, revised June, 1975. The final statement was submitted to CEQ and made available to federal, state, and local agencies, and interested members of the public in July, 1975. The Department announced that governmental agencies and the public would be able to submit comments on the final OCS programmatic EIS during the 60 day review and comment period following its publication.

As in the case of this proposed OCS oil and gas lease sale #41, the Department has committed itself to prepare a site-specific draft environmental impact statement for each OCS oil and gas lease sale that may be proposed. This is in addition to preparation of the programmatic EIS.

## II. DESCRIPTION OF THE ENVIRONMENT

### A. Geologic Framework

#### 1. General Geology

The physiographic features of the northern Gulf of Mexico can be divided into two major provinces; the clastic-terrigenous area off Texas and Louisiana and the carbonate province to the east of the DeSoto Canyon (general Gulf, Graphic 1, Vol. 3; Bergantino, 1969).

The Gulf of Mexico presently represents a subsiding ocean basin partially filled with sediment. The abyssal Gulf is underlain by a simatic (oceanic type) crust; Wilhelm and Ewing (1972) believe that this crust developed to the late Paleozoic. In the Jurassic (about 180 to 150 million years ago) the Gulf was a shallow enclosed sea similar to the present Caspian Sea in southwest Asia and extensive evaporites of salt and anhydrite were deposited. Isolation of the Gulf waters may have been caused by extensive growth of carbonates across the west Florida shelf to the Yucatan Peninsula. Subsidence of the Gulf was as great as 10,000 feet during the Cretaceous. The opening of the Gulf occurred during the Laramide mountain building revolution (Cretaceous to Paleocene) when the carbonate growth was retarded. Subsequent erosion between Florida and the Yucatan has constructed an extensive opening to the Gulf bounded by the Campeche slope and escarpment on the southwest and the Florida slope and escarpment to the northeast (central Gulf, Graphic 1, Vol. 3). Subsidence, sedimentation, and erosion have built the

submarine topography as depicted in bathymetric maps of the Gulf by W. C. Holland, 1970, which is the major source of the bathymetry shown on the series of visual graphics developed for this statement.

The continental shelf is a gently sloping submarine plain (less than $1^{\circ}$) of varying width forming part of the border of the continent out to a water depth of approximately 450 feet, at which point the continental slope begins. The continental slope has a steeper gradient (approaching $5^{\circ}$), extending from the continental shelf to the oceanic depths. The northeastern Gulf shelf varies in width from about 12 miles off the Mississippi River delta to about 140 miles off Crystal River, Florida.

Comprehensive discussions of the geologic framework of the Gulf of Mexico can be found in past Environmental Impact Statements:

For Mississippi, Alabama and Florida, MAFLA OCS Sale #32 FES 73-60, Vol. 1 pp. 106-117, (USDI, 1973a).

For East Texas, OCS Sale #34, FES 74-14, Vol. 1 pp. 49-61 (USDI, 1974a).

For Louisiana, OCS Sale #36, FES 74-41, Vol. 1 pp. 55-83, (USDI, 1974b).

For South Texas, OCS Sale #37, FES 74-63, Vol. 1 pp. 61-86, USDI, 1974c).

2. Status of Geologic Mapping in the Gulf of Mexico Area

To gain a better understanding of the geology of the Gulf of Mexico several visual graphics were prepared at a scale of 1:1,000,000 (Universal Transverse Mercater) from a considerable amount of published and unpublished information. Graphics 2 (Volume 3) depicts the physiographic and geologic features

both near surface and at depth. Although this data is necessarily generalized due to scale restrictions and lack of complete detailed information throughout the Gulf of Mexico a comparison of the geologic graphics with the graphics 1, 3 and 4 (Vol. 3) will give substantial information about the area. A comparison of salt dome locations and the production trends on graphics 2 (Vol. 3) with the lease status maps (Graphics 1, Vol. 3) will give an overview of areas of success, failure and future potential in the area of the proposed sale. An intercomparison of the bottom sediment (Graphics 3, Vol. 3), geology (Graphics 2, Vol. 3) and undersea features (Graphics 4, Vol. 3) will give the viewer information on the origin and location of fishing banks and unique areas. A comparison of undersea features (Graphics 4, Vol. 3) with the lease status maps (Graphics 1, Vol. 3) will show where prospective areas are in relation to areas requiring special stipulations.

The source of most available data on coastal Texas is the Bureau of Economic Geology, University of Texas. This group, under the dirrection of Dr. W. L. Fisher (see Bureau of Economic Geology Annual Reports 1972 thru 1975) prepares environmental geologic maps at a scale of 1:24,000 for the seven coastal areas of Texas covering a strip of the coastal zone approximately 50 miles wide. These maps include the areas from 10 to 15 miles offshore and 35 to 40 miles onshore and are published at a scale of 1:125,000. Eight special use maps are published at a scale of 1:250,000 and include:

(1) Physical properties map

(2) Mineral and energy resources.
(3) Environments and biologic assemblages.
(4) Man-made features and water systems.
(5) Active processes.
(6) Current land use.
(7) Rainfall stream discharge and surface salinity.
(8) Topography and bathymetry.

This system of mapping appears to be one of the most efficient facilities for portraying coastal environments and resources for coastal zone management. A most desirable route of coastal mapping would be an interconnecting series of maps for all of the U. S. coastal zone similar to the Texas system.

The geologic information used for Graphic 2 (Vol. 3) was taken from several generalized sources including:

Geologic Map of Louisiana by Rufus J. LeBlanc, 1948

Geologic Map Coastal Louisiana by D. E. Frazier, 1967

Geologic Map of Mississippi by Miss. Geological Survey, 1969

Geologic Map of Baldwin County, Alabama, P. C. Reed, 1971

Geologic Map of Mobile County, Alabama, P. C. Reed, 1971

Tectonic Map of Louisiana, Pl. II, Lafayette, Geological Soc. 1973

Production Trend Map Pl. I, Lafayette Geological Soc. 1973

Production Trend Map of Gulf, USGS, Metairie, La. 1974

Oil & Gas Map of Louisiana, La. Geological Survey, 1973

AAPG Tectonic Map, Gulf Coast, 1972

GSA Bull. Vol. 83, Wilhelm & Ewing, 1972

AAPG - U. S. Geological Highway Map (Texas), H. B. Renfro, 1973

Offshore Louisiana Oil & Gas Fields, Lafayette Geological Survey, 1970

AAPG Bathymetric Map, Gulf of Mexico, W. C. Holland, 1970

Geologic Map of Louisiana, Busch _et al_., 1974

Physiographic Overview of South Louisiana, 1972 Atlas Inventory of Basic Environmental Data, U. S. Dept. of the Army, 1972

Subsurface Fault and Salt Dome Map, Environmental Atlas for South Central Louisiana, Gagliano, _et al_., 1973

Geologic Map of Florida, Vernon and Puri, 1964

It should be noted that Louisiana is particularly in need of a modern compilation of coastal Geology. The source that is presently the most complete and reliable is the compliation by Busch _et al_. (1974). Another modern study of importance for south-central Louisiana is the joint Corps of Engineers-Sea Grant, Environmental Atlas Report No. 8 Volume 2 by Gagliano _et al_. (1973). Also the Corps of Engineers in New Orleans will be printing a new map of the geology of south-central Louisiana at a scale of 1:250,000 as part of their extensive River Basins Study Program.

Alabama should be noted for producing detailed modern maps of their state on a county wide version as well as a 1:500,000 version reduced from the larger scale maps.

Mississippi Geological Survey (Moore, 1969) has produced an impressive cross section of the state from numerous well and seismic

exploratory data detailing the structure and stratigraphy of the area. A recent study of note in the north-central Gulf is the Mississippi Superport Study by the Gulf Coast Research Laboratory, Ocean Springs, Mississippi (C. K. Eleuterius, 1974).

### 3. Petroleum Source and Potential Reservoirs

#### a. Eastern Gulf

Geophysical surveying and onshore drill data have revealed a southward-thickening section of Mesozoic-Cenozoic shallow-water carbonate and evaporite strata beneath the Florida Platform. The thick southern sequence accumulated in a subsiding depositional trough (South Florida Basin) which extended over much of the southern Florida shelf and eastward to the Bahamas. In the more slowly-subsiding northern area of the peninsula, shallow marine deposits are mixed with non-marine clastic material derived from emergent areas further north.

The major positive subsurface structural feature in the region is the NW-SE trending Peninsular Arch, which existed as a topograhic high during Early Cretaceous and early Late Cretaceous time. An auxiliary structure, the Ocala Uplift, extends from the Peninsular Arch towards the Gulf (eastern Gulf, Graphic 2, Vol. 3). The Ocala Uplift probably formed during the Miocene.

The Southwest Georgia Embayment, extends across the northeastern Florida Panhandle into southern Georgia and Alabama. While onshore wells in this area have revealed a Cretaceous-Miocene sedimentary

rock section almost 9000 feet thick (Rainwater, 1971), Maher (1971) estimates the thickness of the offshore section may exceed 15,000 feet.

The oldest sediments overlying the basement to the south and the Louann salt to the north are Upper Jurassic in age, and they, in turn, are overlain by Lower Cretaceous, Upper Cretaceous, and Cenozoic rocks.

The Upper Jurassic section trends in a southeast direction and appears to parallel the Florida peninsula as it approaches the shelf. From its updip position in northeastern Florida it thickens to over 5000 feet towards the southwest across the Florida panhandle. There it consists of continental, deltaic, and marine sandstones, shales, and some evaporites, together with some carbonates, including the prolific oil-producing Smackover limestone and dolomite. The Smackover attains a maximum known thickness of 1,200 feet in a basinward (southwest) direction.

The Lower Cretaceous thickens to over 7000 feet beneath the Florida panhandle, and the rocks grade southward from sandstones into carbonate. Presumably there is a Cretaceous age barrier-reef fringe located basinward of the shelf, and this reef trend extends from Mexico through Texas, central Louisiana, then southeast to Hancock County, Mississippi. Seismic evidence strongly suggests its presence south of the DeSoto Canyon along the Florida escarpment at about the 1,000-fathom bathymetric contour. The trend extends as far south as 27°N latitude. The occurrence of evaporites in the Lower Cretaceous of southern Florida indicates restricted water circulation which could be due to the barrier.

Upper Cretaceous rocks grade from sandstone and shale southward into shallow water carbonates and reach a maximum thickness of 3,000 feet. On the Florida peninsula this section, dominantly chalk, was deposited on a slowly subsiding, shallow carbonate shelf.

Tertiary rocks just west of the subject area thicken to 20,000 feet where they consist of a sequence of sand and shale. The section offshore from Mississippi, Alabama and Florida is mostly carbonate with an average thickness of 6,000 and a maximum thickness of 8,000 feet.

Few wells have been drilled in the eastern Gulf of Mexico, however the commercial shows of oil to date have been a disappointment. Petroleum Information Corporation reports the following as of 10-3-75:

> Industry leased 65 tracts in the offshore Florida region in the December, 1973 federal lease sale of $1,110,373,130. Total exposure was $2.6 billion. Footage for the 12 wells drilled thus far totals 154,863 ft, for an average well depth of 12,905 ft. On an operator-of-record basis, Exxon drilled seven, Texaco two, and Gulf, Sun and Shell, one each.
>
> According to available information, offshore Florida results to date are as follows:

| AREA | TRACTS LEASED | TRACTS DRILLED | WELLS DRILLED | FOOTAGE | TRACTS OFFERED |
|---|---|---|---|---|---|
| Apalachicola So. | 14 | 1 | 1 | 15,663 | 2 |
| Apalachicola | | | | | 2 |
| Pensacola So. #1 | 39 | 6 | 9 | 103,358 | 5 |
| Tampa | 7 | 2 | 2 | 35,842 | 22 |
| Tampa W. #1 | | | | | 19 |
| Tarpon Springs | 5 | 0 | 0 | -0- | 10 |
| | 65 | 9 | 12 | 154,863 | 60 |

There has been significant production from the onshore Mississippi-Alabama-Florida area. Numerous fields have been in operations since 1939. At least 133 fields have been discovered with Mesozoic production.

In addition, there are 23 Mesozoic fields in Alabama and three in the northern Florida Panhandle. Production is mostly centered in the eastward extension of the Mississippi Salt Basin, a structure that contains shallow salt domes (as shallow as 410 feet) and has a large potential for hydrocarbon production (Braunstein, 1958). Alabama fields are smaller than those in Mississippi, but are also located on the margin of the Mississippi Salt Basin. The most productive zones in these states are the Upper Jurassic, Lower and Upper Cretaceous, the main producing formations are the Tuscaloosa, Eutaw, Paluxy and Glen Rose formations, all of which are sands (Rainwater, 1970; and Braunstein, 1958). Production in Florida is limited to the Upper Jurassic, although several hundred wells have been drilled. The Jay field, located in Santa Rosa County in the panhandle was discovered in 1970, and is producing from the Upper Jurassic Smackover Formation which is a very prolific oil producing limestone and dolomite onshore Mississippi, Alabama and Florida.

Four fields are active in South Florida, the largest of which in the Sunniland field. All of these fields are in the Lower Cretac eous Sunniland Limestone, and are part of the thick shale and carbonate sequence of the South Florida Embayment. There is some promise for large fields in this trend which is continuous onto the continental shelf of West Florida. Stratigraphic and reef traps are the most likely types of oil reservoirs, although some structural traps may be present and are potential producers.

The Upper Jurassic and Lower Cretaceous rocks are most prospective for oil and gas. Production from the Lower Cretaceous is anticipated

to be from carbonates in south Florida, but sands are the most prospective in the Offshore Panhandle Florida Area.

Upper Cretaceous and Tertiary rocks are not considered as prospective with the possible exception of the Lower Tuscaloosa sandstone in the northern most part of the area, and perhaps some Lower Miocene-Oligocene "reefs" to the northwest.

Farther south on the West Florida Shelf, there is abundant evidence of reefs of probable Lower Cretaceous Age. There is a strong possibility that production could occur from these reef structures and from the seaward continuations of the thick sequence of strata in the South Florida Embayment.

b. Central and western Gulf

The most prominent structural anomalies are salt domes (central Gulf, Graphic 2, Vol. 3) and a series of regional, down-to-the-Gulf faults which have materially affected sedimentation across them. Less common are deep seated, low-relief up-lifts and shale domes (western Gulf, Graphic 2, Vol. 3). These structural features are related to the presence of an underlying salt basin and the Cenozoic sedimentary wedge which has gradually advanced seaward across it.

The abundant salt dome structures around which most of the oil pools off East Texas and Louisiana have formed are rare off South Texas. Although salt is thought to be present at depth, it has not formed diapirs so freely for reasons not well understood. Large salt structures are present in deeper water near the base of the slope, but they are not structurally similar to the pircement domes to the northeast, and their trapping capabilities are not known. Several large, linear deep-seated anticlinal structures are present near the mid-shelf area

but little can be said of their origin on the basis of available seismic records. In the coastal area from Corpus Christi to Matagorda Bay, a number of domes with cores of shale are present. Their extent is not fully known, but hydrocarbon production has been obtained from at least a few.

A series of regional faults commonly called"growth faults" are present in the Texas-Louisiana subsurface. They are aligned approximately parallel to the coast. These are normal faults, long and arcuate in the horizontal plane, with large amounts of vertical displacement downwards into the coastal basin. Rock units commonly show greater thicknesses on the downthrown sides of these faults; thus fault movement and deposition must have been essentially contemporaneous. The downthrown section acted as a topographic depression for localized deposition.

The environment of sediment deposition is most significant in its relation to oil and gas production. Sediments deposited on the outer shelf and upper slope have the greatest potential for bearing hydrocarbons for the following reasons:

(1) This is the location where coarser, nearshore sands interfinger with the organic-rich marine shales, thus providing an optimum ratio of sandstone to shale. The shale forms the source-rock which provides the oil and gas and the sandstone provides the reservoir into which the hydrocarbons migrate.

(2) In this environment, the organic material deposited with the fine-grained clays and muds is preserved, and not oxidized as it might be in shallower, more turbulent water.

(3) At this location, the increased overburden of the prograding shallow marine deposits over the plastic salt and marine shales initiates salt flow which triggers the growth of salt domes and regional expansion faults, thus providing potential traps for the hydrocarbons.

This environment, therefore, is the optimum one for providing the three ingredients necessary for the successful formation and accumulation of oil and gas--reservoir rock, source beds and traps. Environments seaward of the outer shelf-upper slope have progressively less sand to act as reservoirs, and landward environments have progressively less source material, i.e., organic material.

During the Miocene, Pliocene and Pleistocene, large volumes of sediment derived from the Mississippi River system were supplied to the offshore Louisiana area. The Texas shelf, at the same time, received smaller volumes of sediment because it was on the western border of the Mississippi River depocenter.

Since natural production of oil and gas frequently occurs along the continental shelf-slope break, the progradation of the north-central Gulf depositional regime has resulted in the migration of this

production zone seaward, developing a series of progressively younger bands or trends. Central Gulf and western Gulf, Graphic 2, Vol. 3, shows the Late Tertiary and Quaternary production trends which underlie this area.

There are approximately 366 fields on the Federal OCS of the Gulf of Mexico. Of these 232 primarily produce gas and 94 primarily produce oil. Production depths range from about 1,000 feet to 29,000 feet, and most production occurs between 8,000 and 12,000 feet. USGS records show that 3.152 billion barrels of oil and condensate and 19.8 trillion cubic feet of gas have been produced from Federal OCS lands as of October 1973.

The most prolific offshore production comes from the Miocene of the eastern Louisiana OCS. This area, as currently defined, has more oil than the remainder of the Texas-Louisiana area. The next most productive trend is the Pliocene trend of central Louisiana OCS which produces about 50% oil and 50% gas. Further to the west this producing trend dies out. The Miocene of western Louisiana is the third most productive trend producing mostly gas, and the Pleistocene of western Louisiana ranks fourth.

The prospective horizons of the upper slope of offshore Texas should consist of a veneer of Miocene and Pliocene with intervals of Pleistocene. The Pleistocene sediments are considered the most prospective reservoir beds and the thickness of these deposits on the slope is variable but is at least 10,000 feet.

The clastic sediments derived from the ancestral Mississippi River system have built out as deltaic deposits in the Gulf. The prospective sediments underlying Texas-Louisiana shelf are those of Oligocene, Miocene, Pliocene and Pleistocene Age.

(1) Oligocene Sediments - The Frio Formation is the most prolific oil and gas producer in south Texas. About 90 percent of the hydrocarbon reserves in south Texas are found in this formation.

The prospective Frio section thickens from a few hundred feet to more than six thousand feet. Regional structural maps indicate that a drilling depth of 15,000 feet or more will be required to test the prospective sections in offshore south Texas areas.

(2) Miocene Sediments - The Miocene trend is less prospective in Texas compared to offshore Louisiana. At the end of Oligocene time, the depocenters for continental-derived sediments shifted eastward, and the Mississippi River system brought to this rapidly subsiding area great quantities of sand, silt and shale. Much of this sediment was deposited in deltas and considerable amounts of clay and silt were carried by longshore currents to the innerdeltaic offshore area farther west. During early Miocene, the area of maximum sedimentation was located in southwest Louisiana but gradually shifted to southeast Louisiana in later Miocene. The Miocene section of southeast Louisiana is the thickest in the Gulf Coast Province. Small rivers (Rio Grande, Nueces, Colorado, Brazos, Trinity and Sabine) did transport a considerable amount of sediment to offshore

Texas, but they did not construct deltas of the magnitude of the Mississippi Delta. The sands that reached the sea were distributed laterally by longshore currents and formed various islands by wave actions. The finer sediments were deposited in lagoons, bays, coastal marshes, and in the neritic zone. The Colorado-Brazos River system did build several large deltas during Lower Miocene time when the area north of the Balcones fault zone in central Texas was uplifted and became an important source for sediments. The largest Colorado-Brazos delta is located shoreward of East Breaks Canyon (western Gulf, Graphic 4, Vol. 3).

(3) Pliocene Sediments - The Pliocene production in offshore Texas has been of little importance compared with that of Louisiana. Pliocene time was a period of uplift and erosion and the sediments that accumulated in the Gulf of Mexico or that were deposited in the coastal environment are, generally, seaward of the present shoreline. The area of maximum sedimentation in Pliocene time was located off the coast of southeast Louisiana. Much of Pliocene production is confined to the central and southeast Louisiana OCS area. Offshore Texas, two distinct provinces are indicated to exist in the Pliocene Trend, one province occurs in the Texas offshore area south of the San Marcos Arch. Sediments are expected to contain sand derived from the Rio Grande River and associated rivers to the north. The other Pliocene province occurs in the eastern portion of the Texas offshore and continues into the East Cameron and West Cameron areas offshore Louisiana. This province is dominated by salt domes and

deepseated diapirs. The stratigraphic sections in offshore Texas, however, are much thinner than in offshore Louisiana, and exploratory results to date in this province have proved discouraging.

(4) Pleistocene Sediments - Two Pleistocene provinces are indicated in the offshore Louisiana-Texas region. The first Pleistocene province occurs from the Ship Shoal area off Louisiana to the southern portion of the Galveston area offshore Texas. This province has a thick sequence of Pleistocene sediments with favorable stratigraphic conditions for both the generation and entrapment of hydrocarbons in porous rock, and structually, is characterized by salt domes and deeper-seated shale domes and ridges. The trend area, to the east (in West Cameron), is presently being developed as a gas producing province. Several fairly large gas fields have been found, some with associated condensate and oil reservoirs. Also, several wells are now being drilled in acreage offshore Texas High Island area which was leased in June 1973, East Texas Sale. The potential of this province is generally regarded as being very good.

The second province occurs offshore southwest Texas, and generally is made up of the Pleistocene offshore delta of the Rio Grande River. The Rio Grande built a subaqueous delta which prograded across the continental shelf and continental slope. The Pleistocene sediments are typified by a fairly sizable quantity of sand deposited under dominantly marine conditions, with interbedded deposits of continental sand material.

4. Geologic Hazards

A number of important geologic hazards occur in the offshore Gulf of Mexico. In the Texas offshore area the possibility of blowouts exists due to the presence of shallow (about 1000 ft. depth) gas deposits within the sediments. Depper high pressure zones can also cause blowouts during the drilling operation. A third hazard is soft plastic sea floor laced with surficial faults which can present unstable foundations for rigs. A fourth hazard can occur in rough sea floor conditions where coral heads, sharp reefs and structural troughs occur. Damage to the rig in areas of poorly described roughness can occur by jamming the legs or having legs slip off rough surfaces. The problem of locating rigs on a soft plastic sea floor is compounded in offshore Louisiana along the steeper slopes of the Mississippi River delta primarily off Main South and Southwest Passes (Fig. 2).

a. Subsidence

The apparent rise in sea level and/or land subsidence is a hazard along the low coastal lands of Texas and Louisiana.

Along the coastal lands subsidence can not easily be separated from the effects of the rise in sea level because either action allows encroachment of the ocean. Causes of the rise in sea level are generally attributed to the melting of glaciers and polar icecaps.


Figure 2 Relative sediment discharge and land accretion in the active bird-foot delta of the Mississippi River. (Gagliano, et al., 1971)

Land subsidence is generally attributed to extensive pumping of ground water and petroleum which causes a decline in the piezometric pressure in the porous rocks allowing once saturated beds to compress. Subsidence can also occur from sand and sulphur pumping and tunnel mining, however, this is rare in the areas under consideration.

If sea level is assumed to be rising in the Gulf of Mexico, this may not be at a rate greater than 1.3 feet in 62 years if Galveston, Texas is to be considered at a zero subsidence rate. NOAA's National Ocean Survey has maintained tide gauges and level data in the Gulf for many years. Data on three long term stations are shown below.

| Site | Years Monitored | Sea Level Change |
|---|---|---|
| Pensacola, Fla. | 47 | 0.5 feet |
| St. Charles, La. | 31 | 1.2 feet |
| Galveston, Tex. | 62 | 1.3 feet |

Land subsidence studied by Turner et al. (1966) for the Houston area is severe and as shown in Fig.3 reaches as great as five feet of subsidence in the past 25 years. This is predicted to continue in some areas to as great as 10.5 feet of subsidence, bringing areas below sea level in Baytown and Texas City, Texas.

b. Mud slides

Recent studies of mud slide hazards in the Mississippi Delta were conducted by the U. S. Geological Survey with the cooperation of the Coastal Studies Institute of Louisiana State University.

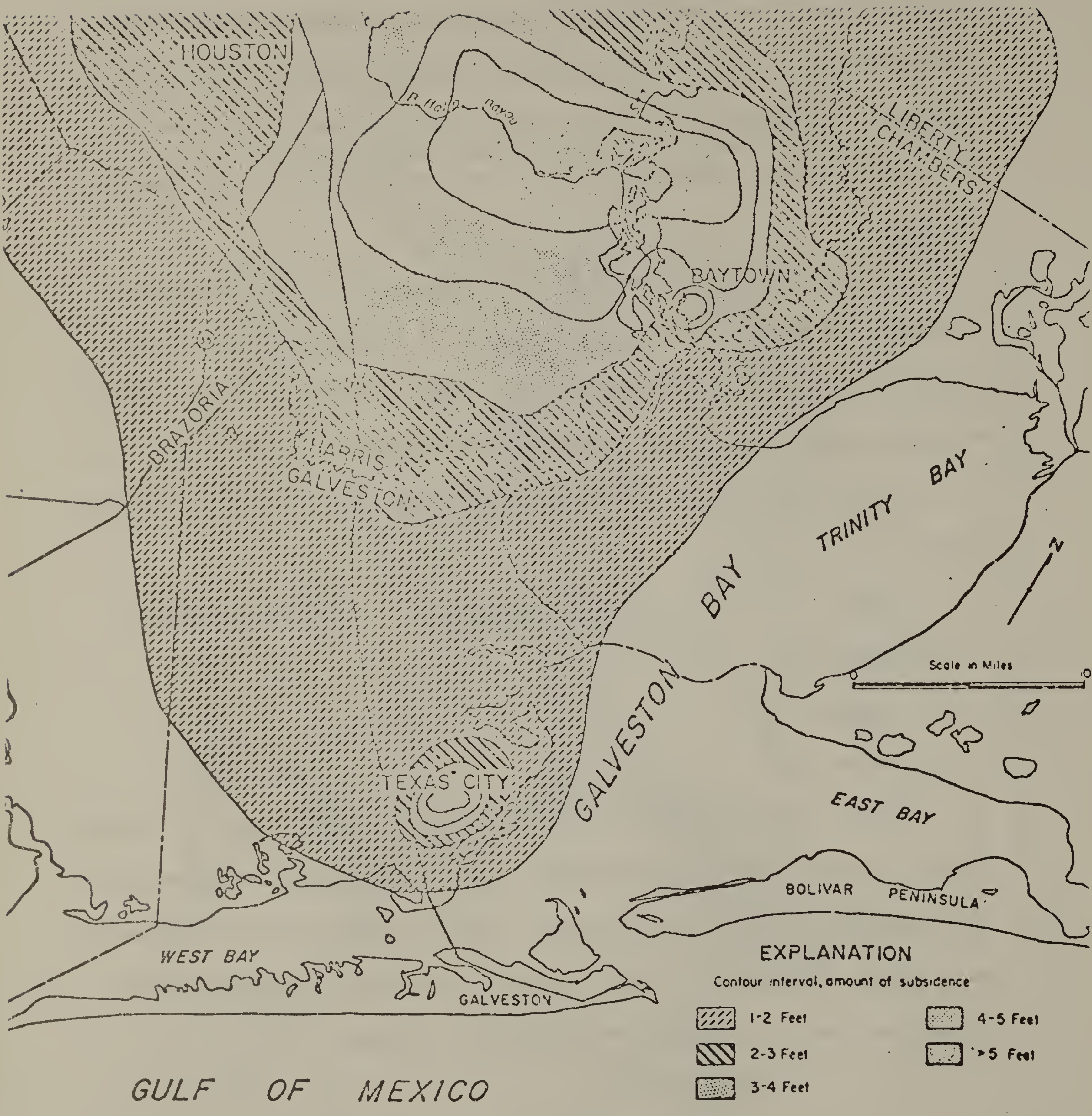



Fig. 3. Land-surface subsidence in the Houston area (1964). After Turner et al. (1966).

Coleman et al. 1974). Fig. 4 delineates areas within which adverse foundation conditions can exist. It has been possible to cope with some areas of unstable conditions through extensive engineering design on the platforms. In some areas of the delta, wave action during hurricanes can loosen more than 100 feet of sediment.

Relatively rapid sediment movement can occur both in the lateral and vertical directions placing a structure in critical trouble. These movements, which may cover larger areas, pose a type of hazard to sea floor structures which is analagous to that posed by landslides to structures on land, except that they may occur on slopes which are almost negligible.

Some of the pioneering work in this field by Shell Oil Company suggests that in some cases fluctuating pressures within the upper 100 feet of sediment caused by storm waves may trigger a sediment failure. Other investigations conducted at the Coastal Studies Institute, Louisiana State University indicate that the content of dissolved and undissolved gases in sediments may play an important role in their instability.

c. Karst topography

Additional geologic hazards to be mentioned are the submerged karst topography (irregular topography developed by the solution of limestone rock by surface and ground waters) extending offshore from the Big Bend area of offshore Florida and cavernous limestone at the base of the Eocene, which presents a potential lost-circulation zone during drilling operations. Although current geologic and geophysical investigations are unable to identify specific typical potential lost circulation.

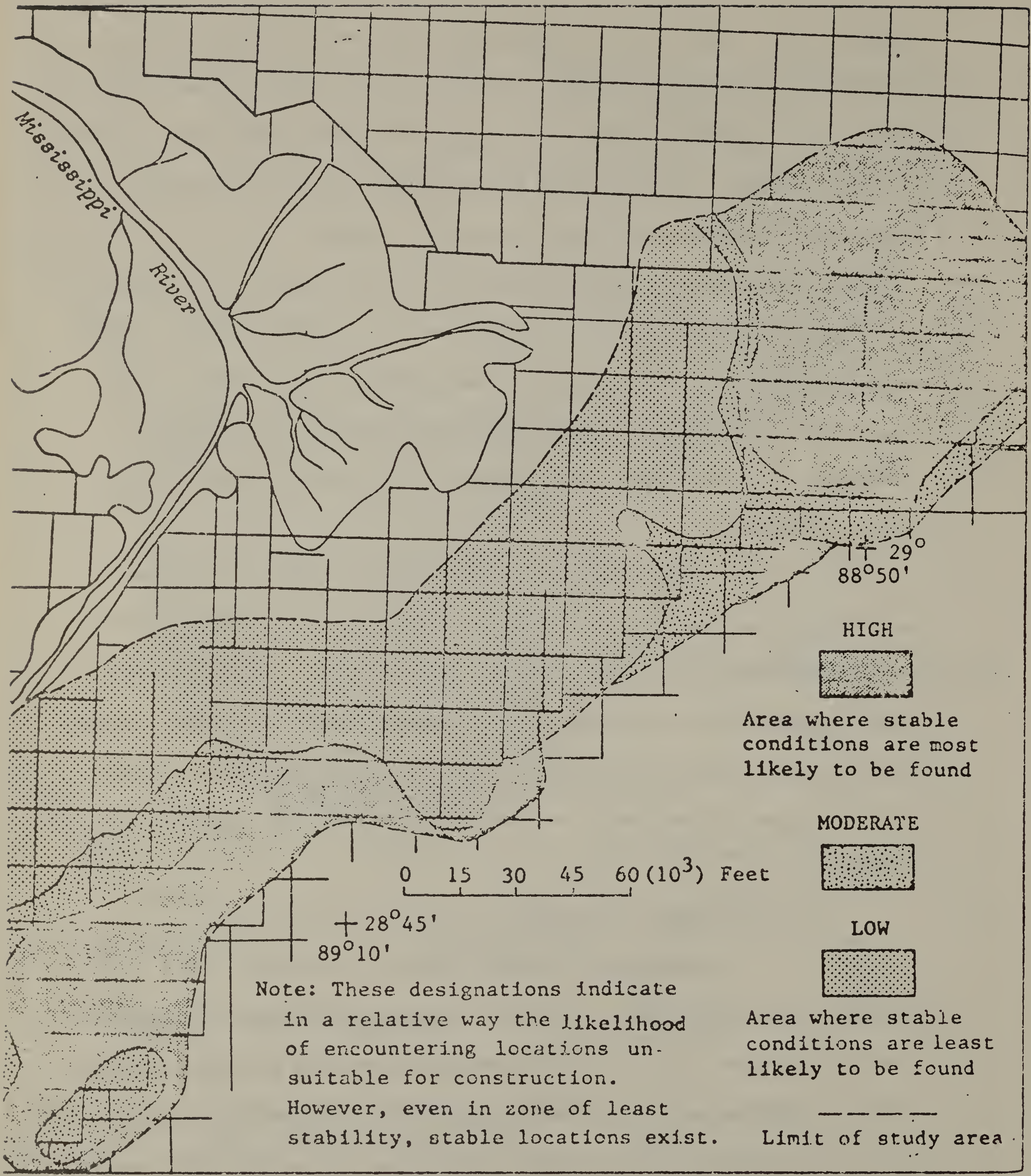



Fig. 4. PRELIMINARY MAP SHOWING ZONES OF RELATIVE BOTTOM SEDIMENT STABILITY. (U. S. Geological Survey, 1974).

zones associated with limestone terrains prior to actual drilling, adequate drilling technology is available to identify such conditions during drilling operations and suitable accomodations necessary to preclude any hazardous conditions can be implemented.

d. Geopressures

Many wells penetrating Mesozoic rocks in the State of Mississippi have encountered geopressures well above the 0.65 psi/ft. gradient which is considered the lower limit of the over-pressured section in the Tertiary of the Gulf coast. Wells in up-dip locations encounter hydrostatic pressures while those in down-dip, or seaward, locations encounter geopressures. Whether these geopressures extend through Alabama and Florida is not known at this time, but the Jay field (in the Florida panhandle) which produces from the Jurassic Smackover formation, does not encounter these geopressures.

In addition to geopressures, hydrogen sulfide ($H_2S$), which does extend into Alabama and Florida, is hazardous to those people working on the rig and to nearby communities.

It is speculative at this time to state that these geologic hazards will be encountered on the OCS of the eastern Gulf of Mexico. However, they should be initially anticipated in those areas where Jurassic and Cretaceous rocks will be penetrated.

e. Earthquakes

Of lesser importance in the Gulf of Mexico is the risk from earthquakes. No known damage has been recorded from earthquakes on an offshore oil platform or installation in the Gulf of

Mexico.

Seismic risk areas were originally designated for all parts of the United States in 1947 by the Coast and Geodetic Survey and revised several times since then. Seismic risk is expressed in arbitrary numbers from 0 to 3. They are based on historical data considering only the intensity of an earthquake, not the frequency of occurrence, and express the anticipated damage that would occur in that area.

Zone 0 - No damage
Zone 1 - Minor damage
Zone 2 - Moderate damage
Zone 3 - Major damage

Most of central and all of southern Florida lie. in an area where the occurrence of seismic hazards is extremely unlikely (Fig. 5). Northern Florida and western Mississippi lie in Zone 1 risk areas which means that there is some danger of earthquakes of low intensity (one which would not do damage to buildings). Small quakes have been reported in central Florida, Gulfport, Miss. (1955) and three were reported in an area approximately 250 miles south of Pensacola, Florida. Because of the geological similarity of the land areas surrounding the Gulf and the adjacent continental shelf, one can reasonably extend the seismic risk zone boundaries some distance offshore.

In the map areas of the western Gulf of Mexico, seismic risk for the area is shown as zero (Algermissen, 1969). This appears to be a rather unique area due to the lack of seismicity. No earthquakes

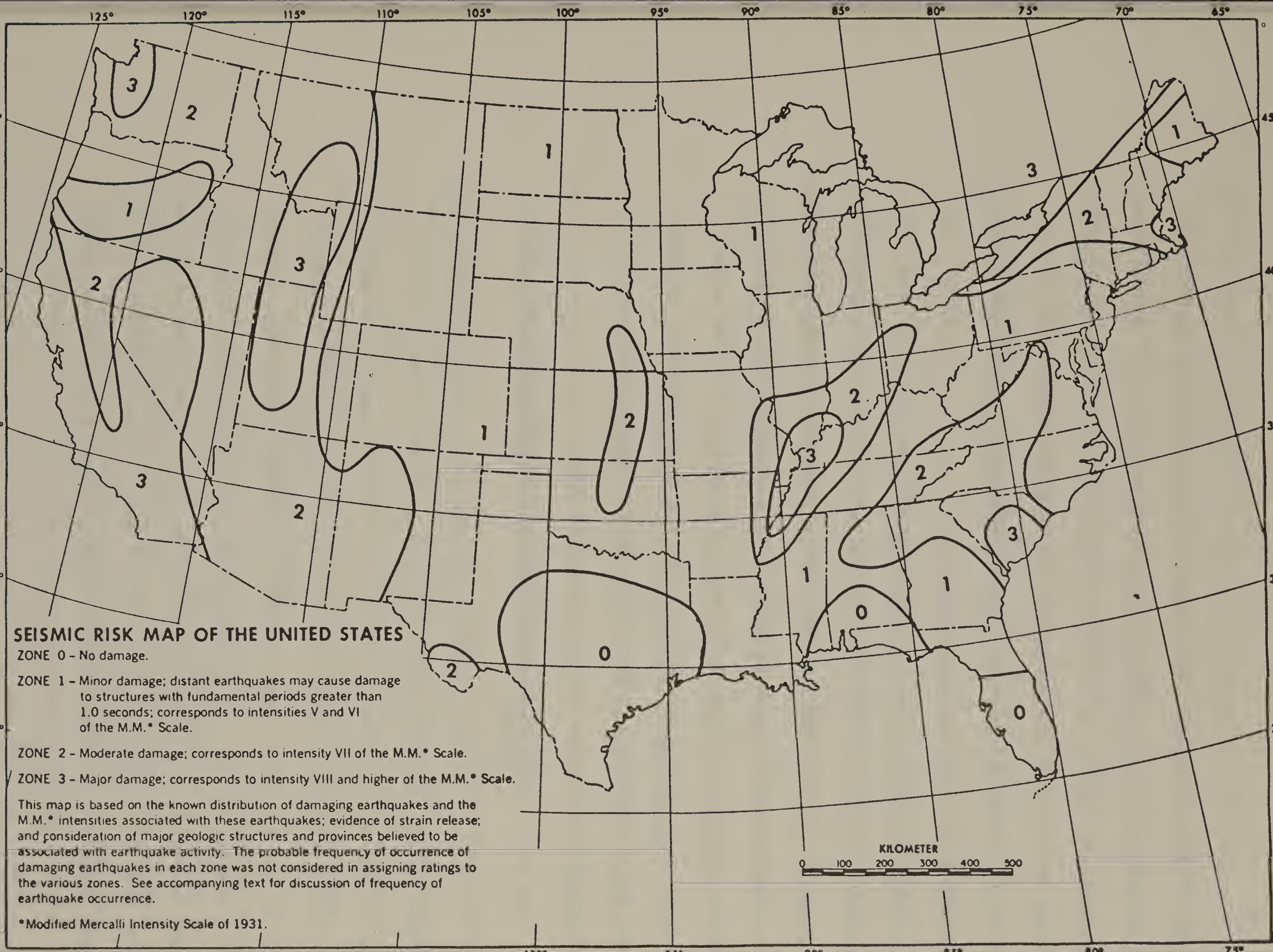



Figure 5 Seismic Risk Map of the United States, (Algermissen, 1969

of any notable intensity have been recorded for this area and only two earthquakes of notable intensity have occurred in the Gulf near this area; one north of Vera Cruz, Mexico and one southeast of the leasing area in over 600 meters of water near 93° W and 27° 30' N. Neither of these earthquakes produced damaging tsunamis and neither were considered well located events.

Assurance that a severe earthquake will not occur in the Gulf OCS region cannot be inferred from historical data, since the ability to accurately locate and measure seismic events developed only recently. Three areas of zero seismic risk, i.e. southern and western Florida, southern Alabama and Mississippi and eastern Texas are shown on the NOAA Seismic Risk Map of the United States. Eastern Texas and the adjoining part of the Gulf of Mexico appear to be the most seismically quiet area of the three zones.

f. Fault displacement, hydrocarbon seeps and seep mounds

Active faults, gas seep areas and seep mounds pose dangers to offshore seabottom operations, however these hazards are some of the most obvious anomalies recorded by geophysical surveys for bottom hazards. Active faults in hydrocarbon producing areas such as the vast salt dome province in offshore Louisiana (central Gulf, Graphic 2, Vol. 3) are generally associated with hydrocarbon seeps (normally gas seeps) and unstable steep mound areas which can often grow to heights of more than 50 feet. Areas underlain by salt domes, such as the Flower Garden Banks, Claypile and Stetson Banks

(western Gulf, Graphics 2 & 4, Vol. 3) are typical areas where active faults, gas seeps and seep mounds have been surveyed. Since these features are notable on side-scan and high-resolution seismic data, suitable hazards surveys are conducted to locate these hazards.

Active fault displacements, gas seeps and seep mounds are generally considered an order of magnitude less hazardous than gas charged sediments and high pressure gas zones due to the recognizability of these features on survey records. Gas charged sediments, high pressure gas zones and gas saturated sediments in delta areas are a significant hazard however. Although geophysical techniques cannot detect high pressure zones directly, velocity and amplitude anomalies have been identified which are abnormally pressured.

g. <u>Bathymetric prominences and steep slopes</u>

Rough sea floor conditions where coral growth, reef scarps and troughs occur can be hazardous to pipeline installations and installations of offshore platforms. Shipwrecks and large artificial reefs must also be avoided as obstructions in place as well as a movable hazard if the area is disturbed by high currents and bottom instability during hurricanes. These problem areas are locatable by modern geophysical equipment used in hazard surveys.

h. <u>Rating of the hazards</u>

It is not entirely realistic to rate hazards since they vary greatly in areal extent, magnitude, intensity, chance of occurrence and degree of mitigation. Each hazard must be studied on a case by case basis in each particular area. However, an attempt to rate the hazards for the Gulf of Mexico for offshore pipeline and platform installation will follow below with the above qualifications

in mind. The hazards are listed with a proposed rating of greater to lessor.

| Hazard | Ease of Identification | Ease of Mitigation |
|---|---|---|
| Unstable bottom, steep slopes, gas charged, hurricane triggered | Yes (Mud slide areas) | No (hazardous to pipelines) extensive pilings for platform strength |
| Unstable bottom, steep slopes, gas charged, gravity triggered | Yes (Mud slide areas) | Same as above |
| Gas charged or geo-pressured zones | Variable | No (blowout preventers) semi-submersible or drillship are safer than platforms |
| Fault displacement, gas seeps and mounds | Yes Geophysical surveys | Yes (moving off - directional drilling) |
| Rough sea floor, shipwrecks | Yes Geophysical surveys | Yes (moving off - directional drilling) |
| Karst topography | Yes Geophysical surveys | Variable |
| Earthquakes | No After the fact | Variable - low probability |
| Subsidence | Variable | Variable - affects coastal zone |

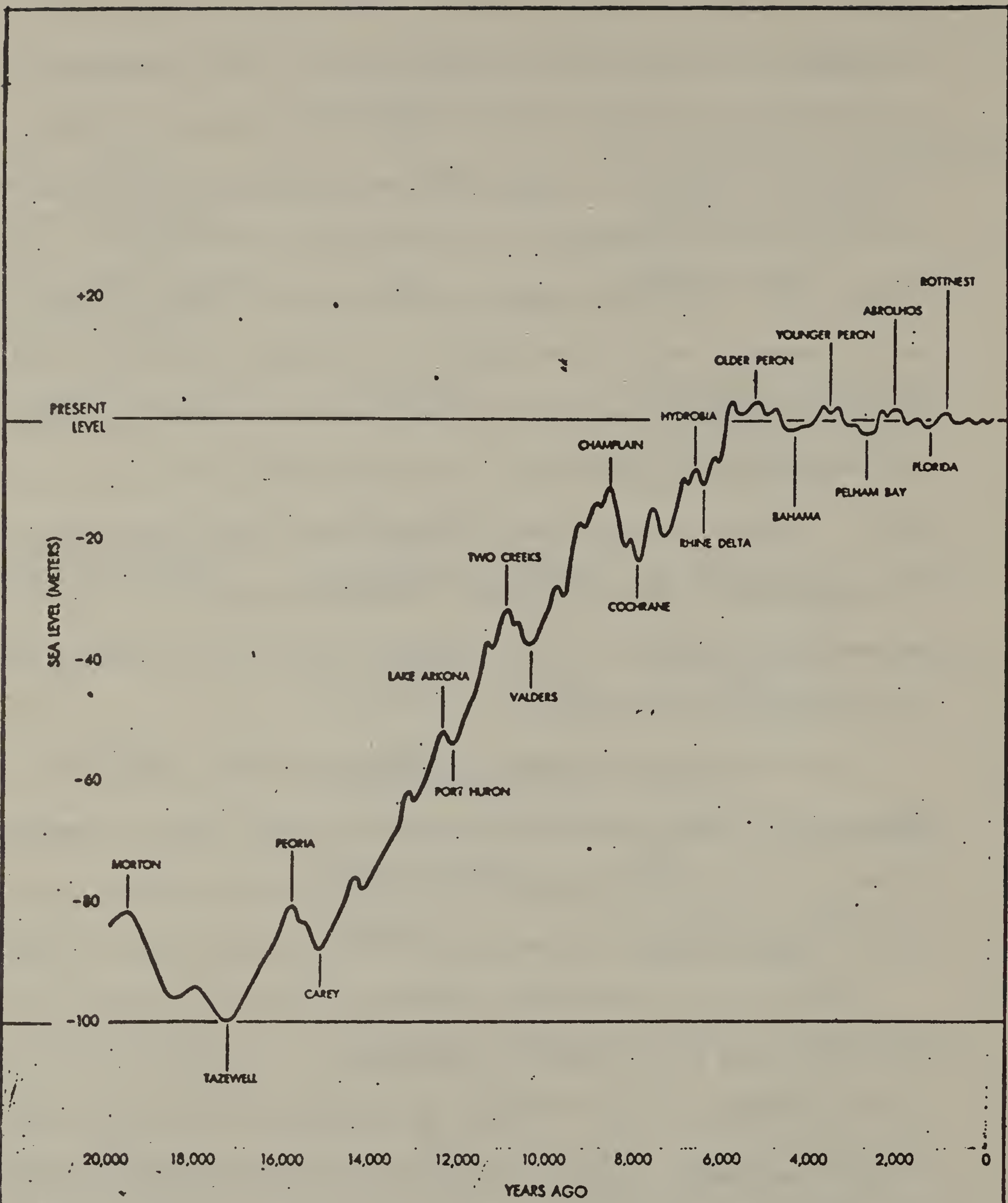
It is standard U. S. Geological Survey procedure in application-to-drill discussions to inform the applicant of all available data concerning bottom conditions, faulting, potential lost circulation zones, high pressures or other potential geologically related hazards, and to require the submittal of an operation plan that includes procedures to accomodate the above hazards.

### 5. Bottom Sediments

Surface sediments of offshore Texas are shown in Visual Graphic #3 (Western Gulf of Mexico). This data is generalized due to the sparse and non-systematic collection of bottom samples, cores, and grab samples in the subject area. The information shown in Visual Grahpics 3 was drawn from the 1970 map by J. R. Grady, NOAA, National Marine Fisheries, Galveston. The greatest concentration of sediment samples have been taken outside of Corpus Christi Bay, Aransas Pass, and Galveston. Most of the samples are shallow (two feet or less in depth) and coverage in offshore Texas would approximate one sample in two lease blocks in about 80% of the bottom area shallower than 200 meters. Samples are much more widely spaced along the continental slope in waters deeper than 200 meters. Anomalous zones in the generalized sediment map (Graphic #3) are shown in Graphic #4 as fishing banks or noteable undersea features.

According to Curry (1960) and Shepard (1960), the surface sediments of the shelf are mainly Holocene or Pleistocene in age and are products of the marine transgression (depositions during the rise and fall of the sea level) following the Wisconsin galciation (Figure 6).

From the Rio Grande River northward, Holocene sediments are generally thin and thicken only at the mouths of rivers with the particular thickening of over 350 feet in the Mississippi Delta area. Holocene sediments (Graphic #3) are usually unconsolidated along




**RISE IN SEA LEVEL** from 17,000 to 6,000 years ago is the most rapid upsurge yet identified in the geological record. The floods that accompanied this 100-meter increase are believed to be the subject of the deluge legends of ancient peoples. The names on the curve indicate the locations where the principal oscillations in sea level were discovered, or where their shorelines are most prominent. Sea level has remained relatively constant for the past 6,000 years, and the amplitude of short-term oscillations is diminishing.



Figure 6

the bays, estuaries, and shoreline of Texas in comparison to the Pleistocene sediments. The top of the Pleistocene in some areas is recognizable on high resolution seismic records. Sea floor composition from Port Isabel to Port Aransas is generally silty clays with sand zones near shore and some sizable areas of shell and silt particularly in Corpus Christi, Galveston, and Aransas Bays. From Port Aransas to the Texas - Louisiana boundary the sediment zones become more varied with longer zones of sand and silty sand with less silty clay present. Part of this increased complexity may be due to the general increase in the number of samples that were collected. Few areas of gravel exist, however, and dredging of shell has a commercial value in Texas state waters. Sediment deposits in the southern area have the unique characteristic of alternating bands of coarse and fine sediments paralleling the coast (Curry, 1960). The coarse sediments are presumed to be relict shallow water deposits whereas the finer sediments are Holocene shelf deposits. Four depositional zones can be recognized in the northeast Texas OCS area. Zone One consists of layered sand from the beachline to the forty foot depth; Zone Two consists of alternating thin layers of sand and mud of irregular widths; Zone Three consists of mud flat deposits with shell banks and shallow water faunal remains; and Zone Four consists of homogeneous clays and silts with deeper water faunal forms.

A number of undersea features are shown in Graphics 3 and 4. These features are presumed to have unusual or noteable sedimentary

conditions and are generally regarded as preferred fishing areas or banks. Graphic 4 shows approximate locations of shipwrecks which could also have archaeological significance as well as fish havens, fishing banks, rocks, holes, and reefs. Names of most of the features in Graphics 3 and 4 are of local use and have no official federal acceptance. In the western Gulf of Mexico a striking number of banks are considered snapper and grouper fishing areas and usually prove to have been caused by the upward thrusting of piercement salt domes. The origin of East and West Flower Garden Banks is the joint growth of upward moving salt plugs and the reef building coral.

The bank which has been studied to the greatest extent is the West Flower Garden. A recent report, "The Geology of the West Flower Garden Bank" by G. S. Edwards (1971), gives a complete history of studies there. A most recent study by several investigators discussed the geology, geochemistry, sediment distribution, and biology of a portion of the bank under the auspicies of the Flower Garden Ocean Research Center (FGORC) during 1972. The 1972 FGORC study concentrated on the high part of the bank in the area of the living reef building coral. A complete coverage of the reefal high was made by the Bo'sun bathymetric survey system of General Instruments Corporation. Underwater observations were made by the Nekton Gamma submersible and skin diving efforts. A wealth of excellent photographs and valuable data was collected during these research missions by Bright & Pequegnat, 1974. The value of

this data has shown that the Flower Gardens are unique in that they comprise in a concentrated area, the most complete assemblage of biota in this part of the Gulf.

Eighteen species of coral have been identified from West Flower Garden Reef, the most prevalent being Montastrea annularis, M. cavernosa, Diploria strigosa, Porites astreoides, and Colpophyllia natans. None are branching forms. In addition, over 100 species of Caribbean reef fishes and 200 species of invertebrates have been identified from the live reef.

The origin of other major banks has not received as extensive research; however, Stetson Bank appears most like the Flower Garden Banks (Bright & Pequegnat, 1974). As exploration in this part of the Gulf continues, many new unique bathymetric features are being discovered. Figure 7 compiled by T. J. Bright, Texas A & M University, shows over sixty such banks,with most of them clustered along the 100 fathom depth contour offshore of western Louisiana and eastern Texas. This alignment also coincides with the Pleistocene gas deposit trend along the edge of the shelf. Major petroleum interest is being devoted to these areas and additional study of these areas seems inevitable. Detailed maps of fishing banks shown in western Gulf, Graphic 4, Vol. 3 have been prepared by Texas A & M University and DECCA Surveys, and are now available in their report of Texas fishing banks to the Bureau of Land Management, New Orleans.

Various alignments of banks are obvious along the Texas coast. It is presumed that the alignment of these banks constituted a record

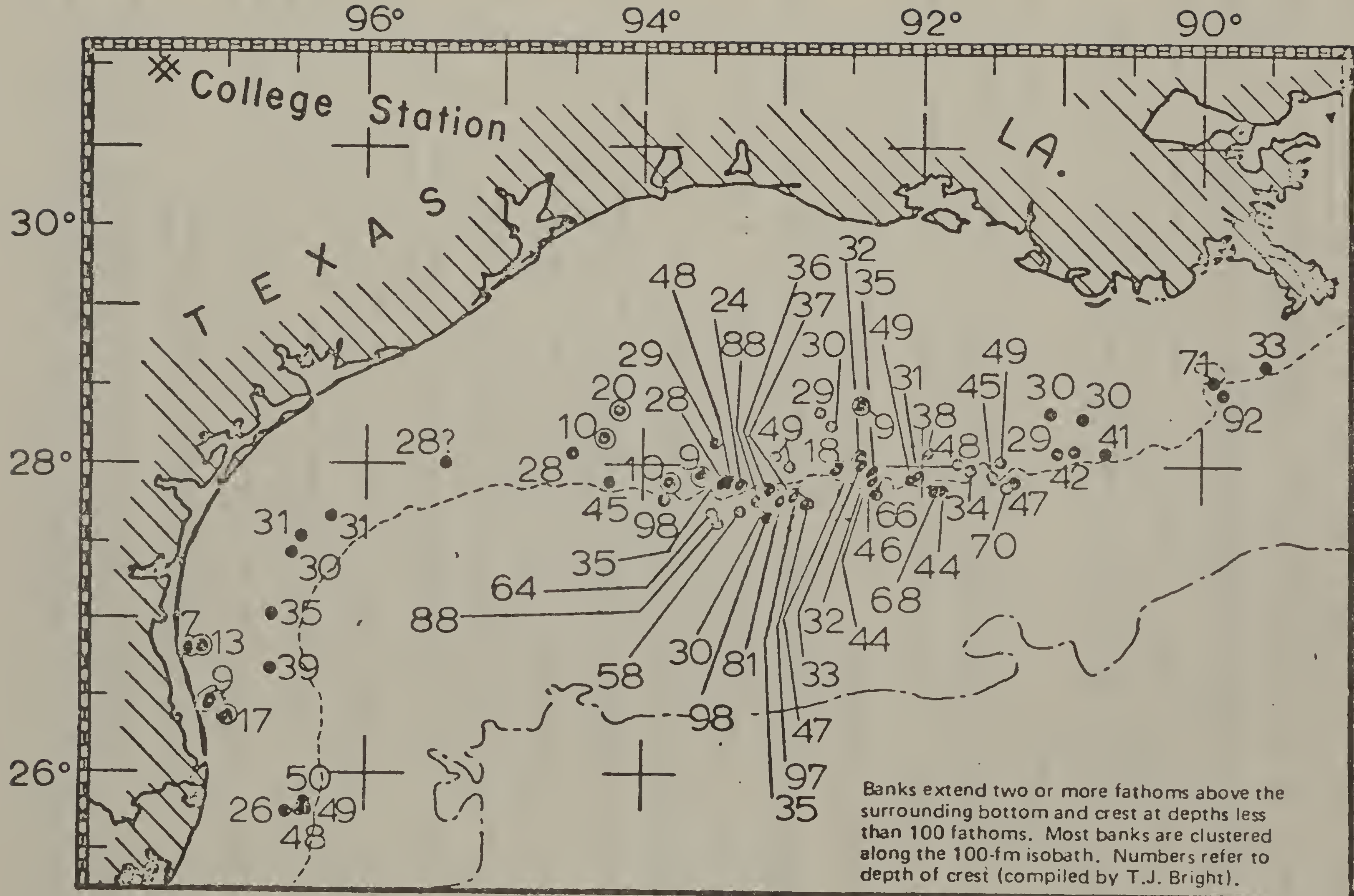



Figure 7 DISTRIBUTION OF SUBMARINE BANKS IN THE NW GULF

of ancient shorelines (Curry, 1960). Many of these banks were the result of a nearshore environment; hence, the oyster, clam, and other shell deposits. In other cases, lagoonal mud deposits and nearshore beach strands have been preserved. In most cases, these banks were presumed to have developed during the Pleistocene and Holocene; however, research on many of these features has been either cursory or nonexistent. Many banks probably existed during various stands of sea level in late Pleistocene where shell growth or calcareous cementation of sediments occurred. This condition could have occurred out to the present 100 meter water depth (Figure 6, Fairbridge, 1960). As the beach lines migrated due to changes in sea level, the unconsolidated barrier deposits or topographic highs along the beaches were destroyed and reworked, leaving the shell beds and cemented sands and clays as bathymetric highs due to their resistance to erosion.

The Mississippi Fan dominates the north central Gulf region of the Gulf of Mexico (central Gulf, Graphic 2, Vol. 3). This thick accumulation of primarily Quaternary alluvium extends over a 160,000 square mile area including parts of the shelf, slope, rise, and abyssal floor. Bottom gradients range from $2^{o}$ near the apex to about $0.3^{o}$ at the outer margin more than 400 miles to the southeast. Within this slope regime the greatest change in gradient occurs roughly at the 2,500 meter isobath and arbitrarily divides the fan into upper and lower segments (Huang and Goodell, 1970).

Historically, the site of active deltaic build-up along the Loui-

siana coast has shifted several times during the past million years. Kolb and Van Lopik (1966) identified at least seven sub-deltas of the Mississippi Delta complex (Figure 8). The river's modern "birds-foot" delta, the Balaise Lobe, extends underwater almost to the continental slope, and represents the uppermost part of the Mississ-ippi Fan. Discussion of delta and fan deposits is included in the Geologic Hazards (Section 4).

Sediment maps for the Gulf of Mexico (Graphics 3, Vol. 3) have been compiled principally from a map by John Grady (1970). Addit-ions to John Grady's data have been made principally in the location of hard banks, coral banks, gravel and shell areas taken from other sources such as commercial fishing bank maps, industry surveys and personal communications with university researchers, sports and commercial fishermen.

Localized sediment maps for the areas south of Timbalier Bay to Grand Isle (Gulf Universities' Research Consortium, 1974), Miss-issippi Sound (from Eleuterius, 1974), and Mobile Bay to offshore Alabama (by Ryan, 1969) contain detailed information useful as a supplement to the regional sediment map by Grady (1970).

The Mississippi-Alabama shelf sands may extend as far out as 80 km offshore. They are, for the most part, relict sand deposits which

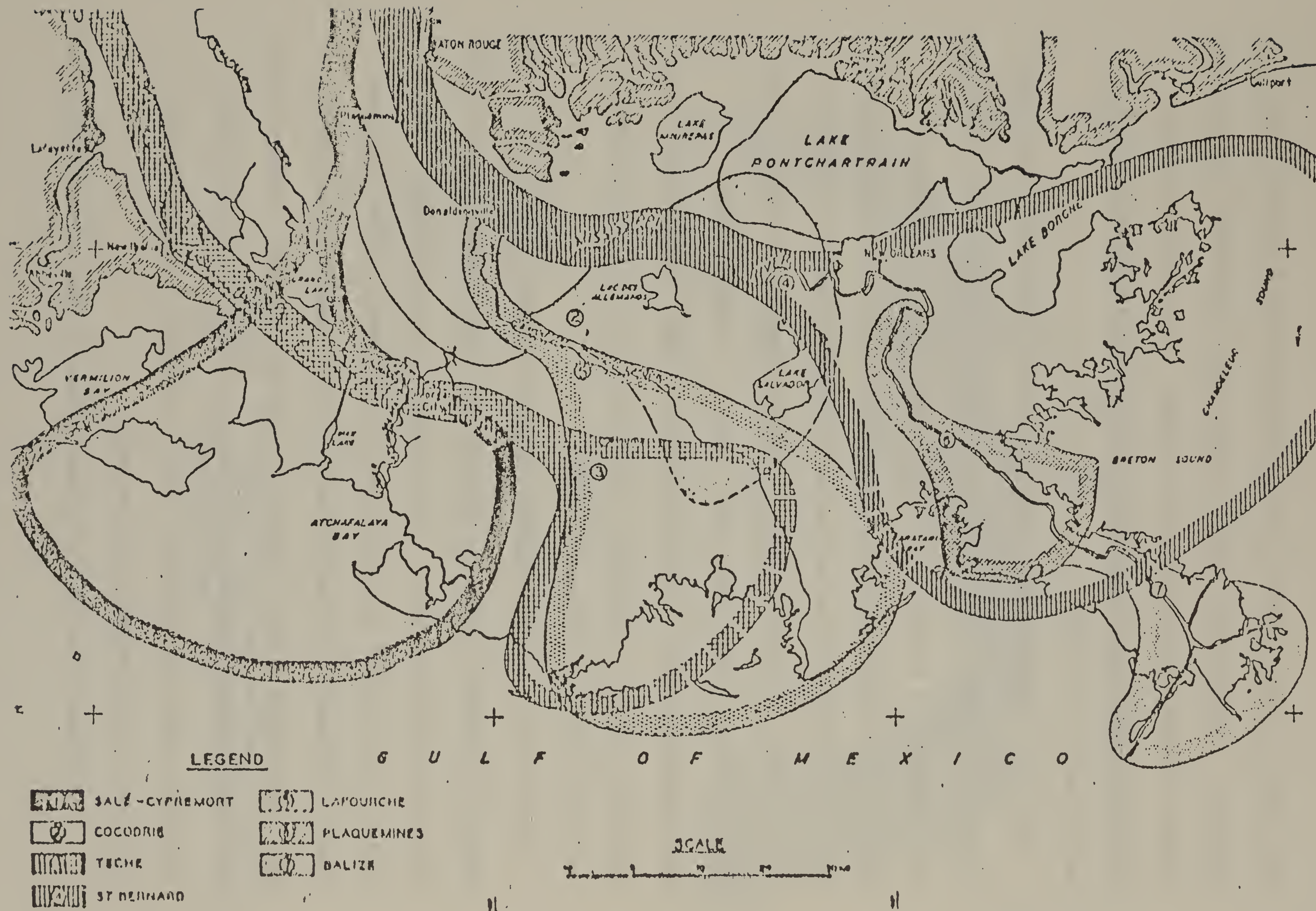



Fig. 8. Sub-deltas of the Mississippi River delta complex- from Kolb and Van Lopik, 1966.

date from the last rise in sea level during late Wisconsin time, see figure 6 (Fairbridge, 1960). Shelf edge "pinnacles" reported off Alabama (Ludwick and Walton, 1957) appear to be from reefs that flourished under more favorable environmental conditions that presently exist.

The most extensive unconsolidated sand cover in the Gulf exists on the West Florida Shelf extending nearly to the coastline (eastern Gulf, Graphics 2 & 3, Vol. 3). These sands are relict deposits mainly of the late Wisconsin Transgression and are a discontinuous and thin covering of the extensive carbonate platform. Sediments covering this platform grade from modern coastal sand deposits seaward to relict quartz sands (see figure 9, Emery, 1968); to sand zones dominated by shell fragments, algae, peletoid, and oolitic carbonate sands, to biogenetic silts and oozes on the outer shelf and slope (Gould and Stewart, 1955).

Recent work on MAFLA sediment studies in five lease areas is summarized by Manheim (1974) in Appendix E. These studies are the most detailed locality studies of five areas of the eastern Gulf of Mexico. Doyle, et al. (1974) characterized the sediments across the areas showing influences of the Mississippi in the western areas with high percentages of clay (smectite) and low carbonate content (seven to twenty percent) grading to the eastern areas off Florida where carbonate sands and carbonate rich silty sands are predominate with kaolinite as the dominant clay mineral.

Carbonate analyses of these sediments were reported by Wanless

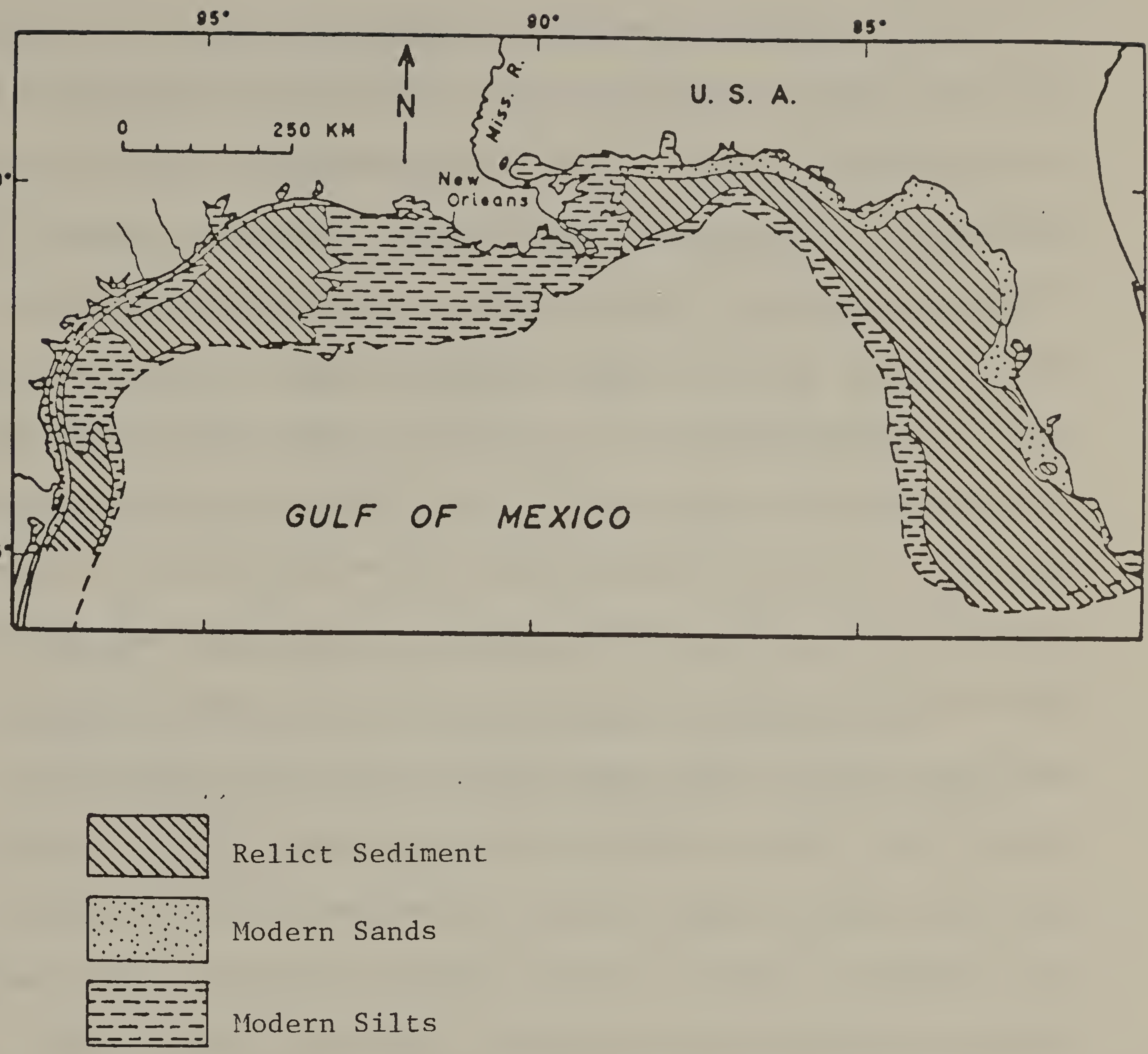



Figure 9 Sediments of the continental shelves in the northern Gulf of Mexico (from Emery, 1968).

and Dravis (1974), included descriptions of surface texture, degree of gragmentation, presence of infilling of grains, color of grains, type, and description of non-carbonate portions of each size fraction.

Relief features or features of unique interest on the shelf in the eastern Gulf of Mexico are both erosional and depositional but are most closely related to sea level changes of the late ice age (Wisconsin). The important physiographic features of western Florida are mapped by Puri and Vernon (1964). Unique offshore features, such as the 70 to 90 foot sand ridges, are mapped by Hyne and Goodell (1967), off Choctowhatchee Bay, Florida. Coral grows in the Middle Grounds Area and to the south and east offshore of Crystal City and Tampa Bay, creating fishing grounds equaled only by the oil and gas platforms in the central Gulf of Mexico and the hard bank areas in offshore Texas (Graphics 2, 3, and 4, Vol. 3). Relief features associated with the shelf edge and slope have been reported by Jordan (1951, 1952 and 1954); Jordan and Stewart (1959); Kofoed and Jordan (1964); Uchupi (1967); and Bergantino (1971) (general Gulf, Graphic 1, Vol. 3). On the carbonate platform of the shelf, extensive low-relief rock outcrops, sink holes (Jordan, 1954; Hippenmeier, 1964), and submarine springs (Brooks, 1961) have been discovered. Recent mapping of submarine hot springs is continuing on the shelf by Pyle (1975).

Arnold H. Bouma in his "Distribution of Sediments and Sedimentry Structures in the Gulf of Mexico" published in Volume 3, Texas A & M University Oceanographic studies.

The Mississippi Fan and major portions of the abyssal plain and continental rise contain sediments that were transported in part by turbidity currents and in part deposited pelagically. Sediments in these areas have been derived from the northern and western shelves and slopes; however, the bulk has been derived from the Mississippi Delta. The midwestern and southwestern Gulf have sediments that are more pelagic in origin. Their carbonate content is high and is made up in major part by foraminifera tests. A low accumulation rate is assumed for this area based on the high degree of bioturbation.

The Alaminos, Old Mississippi and DeSoto Canyons are inactive canyons in which the upper part of the sediment column does not reveal typical submarine canyon characteristics but a rather homogeneous ooze type sediment as filling.

## B. Climate of the Gulf of Mexico Region

### 1. General Climatology and Seasonal Weather Patterns

The climate of the Gulf of Mexico region is broadly determined by the huge continental land mass lying to the north and west, the subtropical latitude, the influence of the persistent Atlantic high-pressure system (Bermuda-Azores) and the warm waters of the Gulf itself.

From March through September the eastern Gulf lies under the western portion of the well developed Bermuda high-pressure cell. Around this cell winds move in a clockwise spiral. Due to this influence winds in the Gulf region are south to southeasterly much of the time with a tropical maritime air mass dominating the region almost completely.

In the western Gulf during the summer months, tropical continental air masses may occasionally approach from the southwestern U. S. or northern Mexico. On these occasions very high temperatures and low humidity extend eastward toward the coast. During the summer the Bermuda high strengthens westward, and the pressure gradient steepens across Texas toward a semi-permanent thermal low in the region of northwestern Mexico. This produces moderate to strong southeasterly winds almost every day.

By May the semi-permanent Bermuda high becomes well developed. Westerly storm systems are generally too weak to penetrate the strong ridge of high pressure extending westward across the Gulf of Mexico.

Easterly moving systems which influence the Gulf coastal weather seldom occur this early in the year. Occasionally, tropical disturbances and easterly waves will appear in the Gulf of Mexico by early summer.

In summer, the Bermuda high becomes very strong and extends its anticyclonic influence over the Gulf. The prevailing southerly winds from the Gulf provide a rich source of moist tropical air which results in almost daily shower activity along the coast and near-shore waters of the northern Gulf. Air mass thundershower activity increases during the day with the greatest activity in the afternoon. Summer rainfall is generally associated with southerly winds. When westerly to northerly winds occur in summer, periods of hotter and drier weather interrupt the moist semi-tropical climate of this coastal region.

By August, easterly waves and tropical storms increase in the Gulf of Mexico and reach a peak in September. They begin to affect the weather in the Gulf with the principal paths of tropical storms into the Gulf coming from the Straits of Florida and the Yucatan Channel. Over half of these tropical storms become hurricanes.

By mid fall the semi-permanent Bermuda high brings its migratory movement eastward in the Atlantic. By November westerly systems bring their influence upon the weather in the Gulf and adjacent coastal regions. Advection (predominantly horizontal, large-scale motions of the atmosphere) and frontal fog make their appearance. The maritime tropical climate along this coastal region afford mild winters,

cool springs, warm summers and pleasant autumns.

In the winter the area is subjected alternately to maritime tropical and polar continental air masses in periods of varying length. This region is usually south of the average track of winter cyclones but occasionally one will move this far south. Westerly systems at times make their influence felt as cold fronts from the northwest push southward into the Gulf of Mexico. The cold air behind these fronts, though modified by the southward journey, brings sudden and occasionally large drops in the temperature. The Gulf of Mexico, with its relatively warm waters, introduces retarding and modifying effects upon cold fronts. As the invading cold air mass pushes out over the Gulf it moves against the strong flow of maritime tropical air in the opposite direction causing the front to become quasi-stationary. At these times the northern Gulf area becomes a favored region for cyclogenesis (formation of circular wind movement and low pressure). When waves develop on the front they are usually associated with an eastward-moving upper air trough. The principal track of the associated low center parallel the Gulf coast or moves inland producing persistent low stratus cloud ceilings and rain in the northern Gulf area. These conditions usually persist ahead of the low centers. The colder air masses in winter tend to gradually lower the sea surface temperature offshore. This plays an important role in the formation of advection-radiation fogs in coastal areas from November through March and the formation of dense sea fog over the relatively cold water surface. The direction of flow of warm air at the surface

near the coast determines where the fog will form. Snow seldom occurs this far south in winter. With the arrival of spring, the occurrence of fog, rain and low ceilings becomes less frequent.

2. Sky Cover and Visibility

a. Cloudiness: Along the Gulf coast cloudiness averages between 0.5 to 0.6 sky cover with relative small seasonal variation. October is generally the clearest month and December through March the cloudiest. The nature of the cloudiness varies with the season. In winter the Gulf coast has occasional gray, overcast days but in summer these are rare.

During the warm season, May through September, cumulus clouds begin developing over northern Gulf waters about 0300 hours and the larger clouds may produce scattered showers which dissipate when carried onshore during the morning by the sea breeze. Onshore cumulus development occurs during the day reaching a maximum in late afternoon, often accompanied by rainfall. (Orton, 1964).

b. Fog: Warm, moist Gulf air blowing slowly over chilled land or water surfaces brings about the formation of fog. From November through April, fog is encountered occasionally at points throughout the Gulf coast region. It is most frequent in the vicinity of harbor entrances and over land areas extending into the Gulf, such as Cape San Blas. Fog forms with southerly winds and dissipates during northerly winds.

Fog is relatively infrequent at most Florida coastal points, with the exception of Tampa in the winter. There is a greater frequency along the Alabama and Louisiana coasts and the Texas coastal

bend, with lesser amounts on the southwest Texas coast. The heaviest occurrence of fog is usually in the early morning hours. It is generally at a maximum in winter with little heavy fog in summer.

3. Surface Wind Patterns

The Azores-Bermuda atmospheric high pressure cell dominates the circulation over the Gulf, particularly during the spring and summer months. In late summer there is a general northward shift of the circulation and the Gulf comes under the more direct influence of the equatorial low pressure belt. During the relatively constant summer conditions, the southerly position of the Azores-Bermuda cell brings about predominance of south-easterly winds. The winds tend to become more southerly in the northern part of the Gulf. During the winter, winds usually blow from easterly directions with fewer southerlies but more northerlies. Winds from west and southwest are rare anytime during the year.

Near the Gulf coast winds are more variable than over the open waters of the Gulf because the coastal winds fall more directly under the influence of the moving cyclonic storms that are characteristic of the continent.

4. Air Temperatures

Average temperatures at coastal locations vary with latitude and exposure. In winter they depend on the frequency and intensity of penetration by polar air masses from the north. These incursions, when they bring strong northerly winds to the Gulf, are called "northers" and may occur some 15 to 20 times between November

through March.

Air temperature over the open Gulf exhibit narrower limits of variation both on a daily and seasonal basis (Fig.10). In July, average temperature over the center of the Gulf is about 85°F and gradually increases coastward to within 10°F of temperatures recorded at coastal localities. In January, average air temperatures over the Gulf are highest in the southeast, near Cuba and the Yucatan Peninsula, and decrease toward the north. East of Brownsville and Corpus Christi, Texas, January air temperatures over the open Gulf average about 65°F; at the Galveston, Texas and Mississippi Delta latitude, the temperature is about 60°F.

5. Precipitation

Average annual precipitation along the Gulf coast increases from approximately 27 inches at Brownsville to over 40 inches at Galveston, 54 inches at New Orleans and reaches a maximum in the vicinity of Mobile, which receives over 68 inches. Peninsular Florida generally receives over 50 inches of rainfall per year; values decline off the tip of Florida where Key West receives 40 inches.

Along the central Gulf precipitation is frequent and abundant throughout the year. At New Orleans, October is the only month with a precipitation average less than three inches. July, the wettest month, receives just under seven inches. Stations along the entire Gulf coast record the highest precipitation values during the warmer months of the year. The month of maximum rainfall for most locations is July, however, at the extreme ends of the Gulf coast, Key West

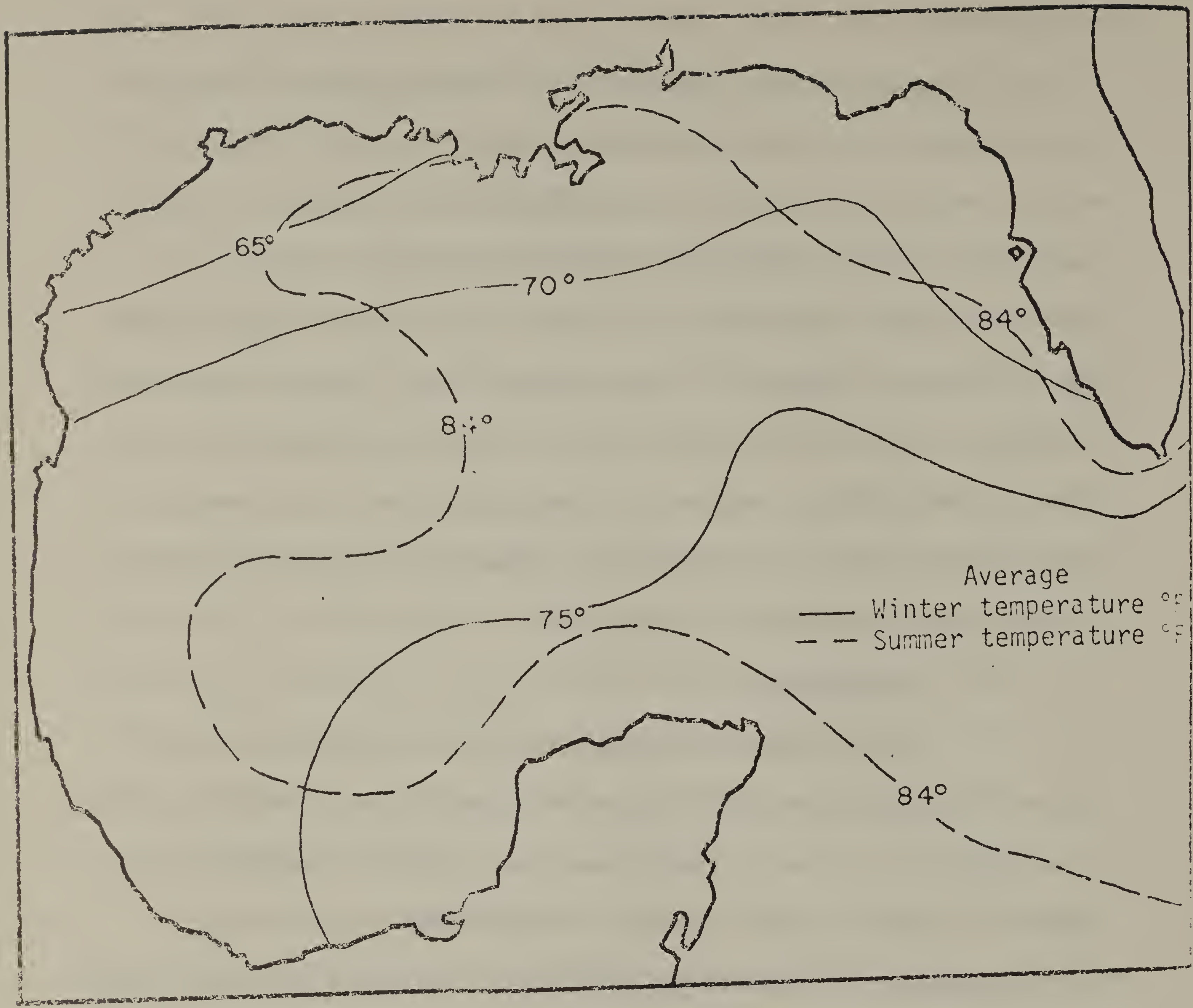



Figure 10 Average summer and winter surface isotherms in °F for the Gulf of Mexico (Leipper, 1954a).

and Brownsville record maximum in September.

These warmer months usually have convective cloud systems which produce showers and thunderstorms; however, thunderstorms of this type rarely cause any damage or have attendant hail. (Brower, et al., 1972).

6. Severe Storms

a. Tropical cyclones

The largest and most destructive storms affecting the Gulf of Mexico and adjacent coastal zone are tropical cyclones. These have their origin over the warm tropical waters of the central Atlantic Ocean, Caribbean Sea or southeastern Gulf of Mexico. They occur most frequently between June and late October (Brower, et al., 1972) and there is a relatively high probability that tropical cyclones will cause damage in the Gulf of Mexico each year. Statistics for hurricanes and tropical cyclones are often lumped together since it is often difficult, especially in the older records, to determine the storm intensity while at sea. The probability of a tropical cyclone or hurricane influencing the north-central Gulf coast during any given year is one in six.

There is no preferred approaching route of hurricane tracks although early season cyclones approach generally from the southeast while later ones are more out of the south. In spite of the fact that most hurricanes form in tropical ocean areas, a few are generated in the Gulf of Mexico. During the period 1901-1971, seven hurricanes

and seven tropical storms formed in the Gulf north of 25°N and east of 85° W. See general Gulf, Graphic 2, Vol. 3, for 1954-1974 hurricane tracts.

Damage from hurricanes result from high winds and, particularly in the coastal areas, the storm surge or tide which is an abnormally high rise in the water level. Maximum surge height at any location is dependent on many factors including bottom topography, coastline configuration and storm intensity. The storm surge at Pass Christian, Mississippi associated with hurricane "Camille" in 1969 was 25 feet, and that associated with "Betsy" in 1965 reached nearly 20 feet at Bayou Lafourche (U.S. Department of the Army, 1973). Hurricane "Camille" was the most severe hurricane in recent Gulf history, with top winds estimated at 201.5 miles per hour, and barometric pressure in her calm eye as low as 26.61 inches of mercury.

The flood tides and high waves carry shells and sediment from deeper offshore areas onto seaward beaches, spreading a veneer of deposits over the broad, flat hurricane beaches. In the marsh areas extensive and prolonged inundation and ponding occurs, resulting in damage or loss to habitat and man-made structures. The storm surge flood may also produce breaches or channels in natural barrier islands or in levees.

b. Extratropical cyclones

In addition to the tropical cyclones, extratropical cyclones that may vary greatly in intensity occur in this area primarily during the winter months. These storms have attained wind

speeds as great as 30 to 50 knots. They originate in middle and high latitudes forming on the fronts that separate different air masses. The Gulf of Mexico is an area of cyclone development during the cooler months due to the contrast in temperatures of the warm air over Gulf waters and the cold continental air over the United States. These storms rapidly dissipate, or move on, after going out over the Gulf of Mexico.

C. Physical Oceanography

1. Circulation

a. Loop current

Circulation in the Gulf of Mexico is irregular and is dominated by the "Loop Current" which is strongest during the late summer through winter. Circulation of these warmer Caribbean waters (Fig. 11) can extend as far north as the Mississippi Delta and eddy currents off the major loop probably account for northern growths of coral such as the Florida Middle Grounds and Flower Garden reefs in offshore Texas. Current trajectories in the Gulf have been mapped for many years by the Naval Oceanographic Office in an Atlas of Pilot Charts, Pub. No. 106, 1955. The surface current wind roses shown in western, central and eastern Gulf, Graphics 6, Vol. 3 are from a compilation of Naval Oceanographic Office data. Additional Loop current data are contained in: Compilation and Summation of Historical and Existing Physical Oceanographic Data from the Eastern Gulf of Mexico, 1975; Mississippi Superport Study (Eleuterius, 1974); and Surface Currents Study, Northwestern Gulf of Mexico (Sweet, 1974). These studies show that water movements in the Gulf of Mexico are controlled by a variety of interacting forces including fresh water inflow from land, currents set up by winds, currents and water transport induced by surface gravity waves, tidal currents, currents associated with internal waves and movement of water masses due to density differences.

The general circulation pattern for the eastern Gulf consists

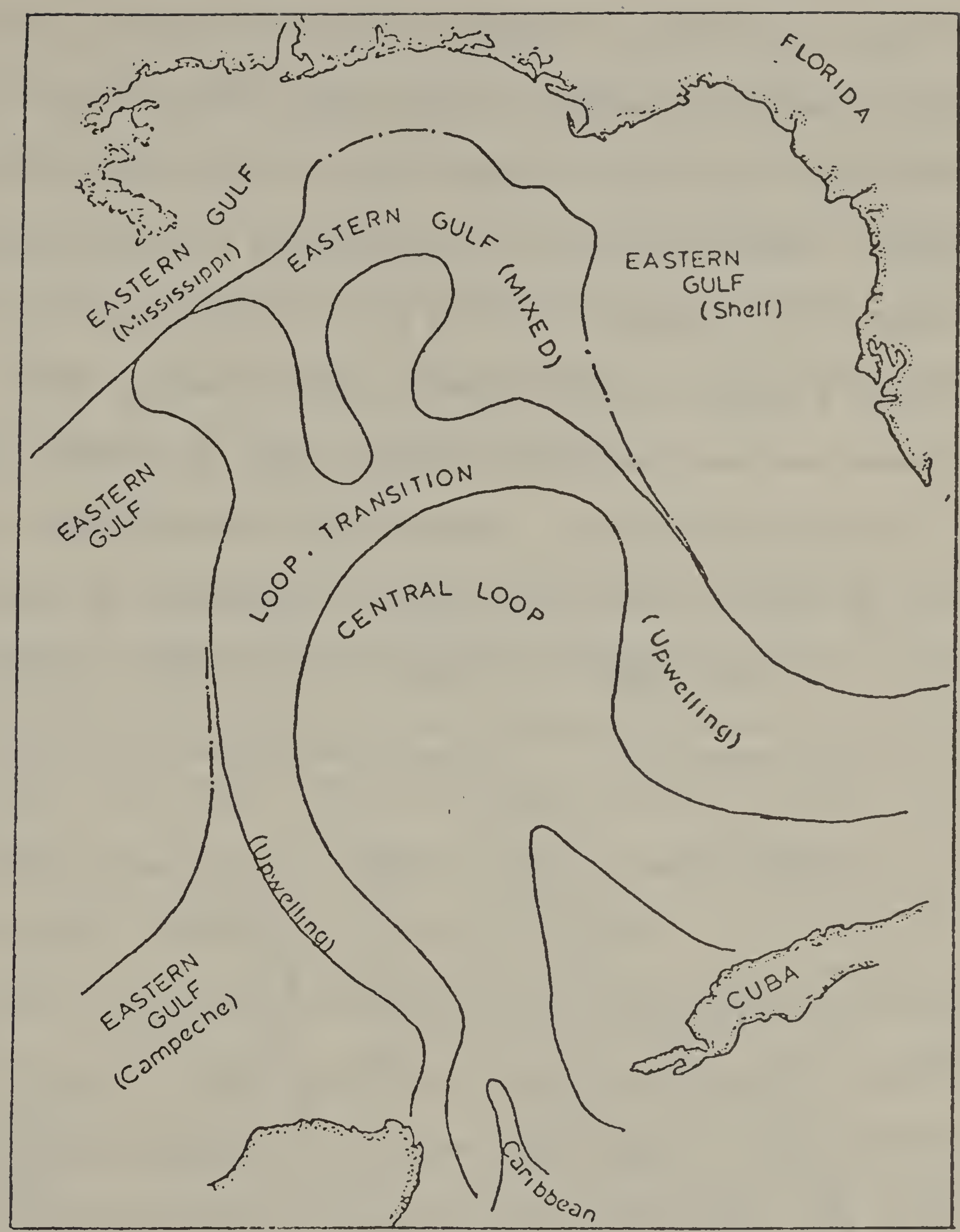



Figure 11 . Water Masses in the Eastern Gulf of Mexico During May 1970 (From Austin, 1971).

of a clock-wise Loop Current flowing in through the Yucatan Strait and out through the Florida Strait (Fig. 12 ). This is essentially an extension of the Yucatan Current which flows into the Gulf, circles to the right and flows out through the Florida Strait to join the Gulf Stream Current. A counterclockwise gyre off the west coast of Florida is a persistent feature, more defined during the winter months, however. The western half of the Gulf has no strong, semi-permanent currents but is characterized by a well-defined pattern of winter flow and a highly variable summer pattern (Nowlin, 1971). There is a general westward sweep of currents along the northern shelf west of the Mississippi Delta. Another mass of water moves northward along the Mexican coast to a zone of convergence off Texas. All the currents in the western Gulf seem to flow toward this general zone.

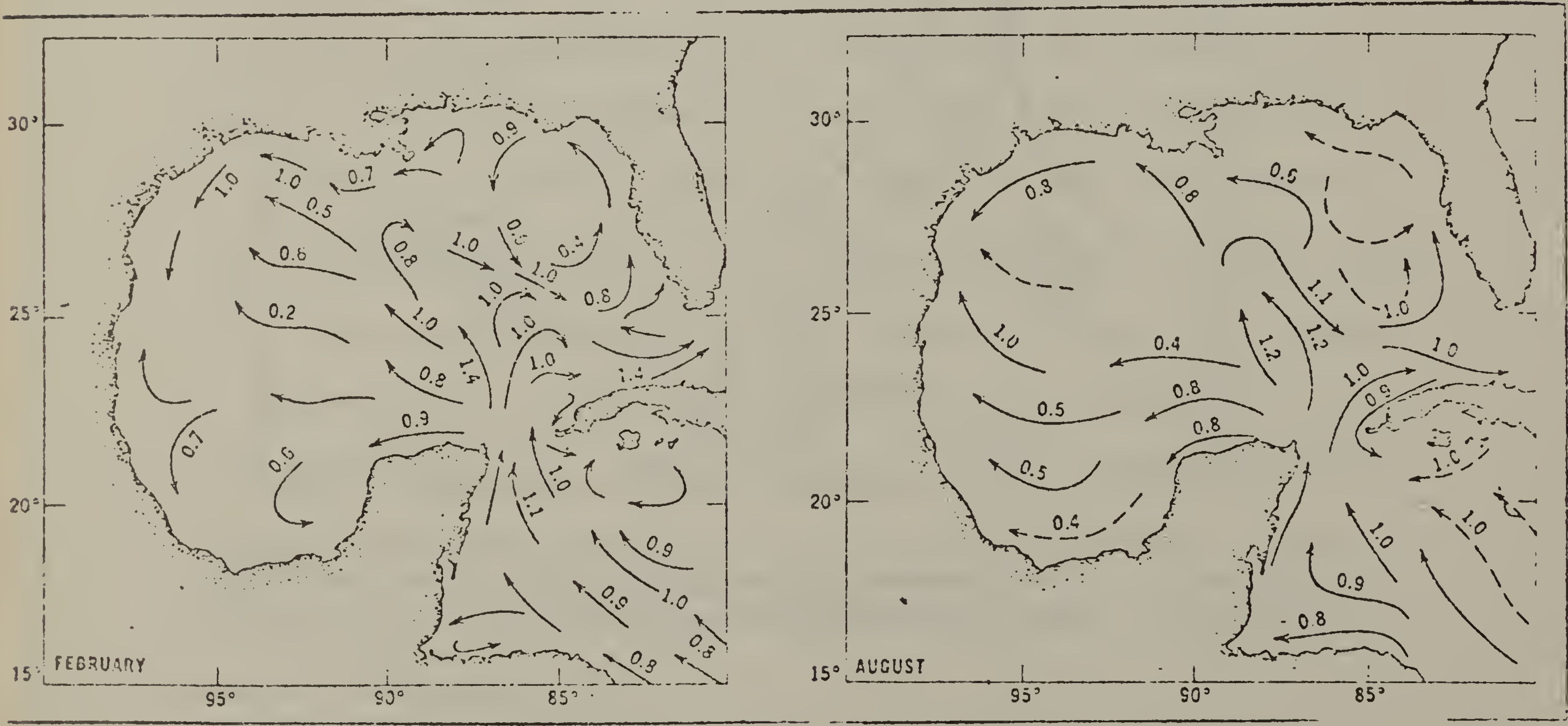



Figure 12 Generalized surface circulation in the Gulf of Mexico inferred from logs of ships at sea. The numbers refer to current speeds in knots, as estimated from ships' drift. (From Nowlin, 1971)

The eastern Gulf shelf from the Mississippi Delta to Cape San Blas is characterized by a very mixed current pattern reflecting influences of variable winds and fresh water inflow upon water mass movements resulting from the Loop circulation. Eastward from Cape San Blas the current directions reflect a semi-permanent counterclockwise gyre which flows northward along the west coast of Florida, swings westward south of Apalachee Bay, and turns south off Cape San Blas. There are places and times where this gyre is weak or nonexistent. Thus, some bays and inlets, as well as some open beaches, are isolated from tidal and current exchanges.

b. Surface circulation

Fig.12 depicts surface circulation trends along the Louisiana coast, emphasizing the general westward movement of currents. The nearshore regime in this area is influenced by several factors, among them winds, tides, offshore current flow and fresh water discharge from coastal rivers. In most areas significant winds are the major control of surface currents.

Currents around the Mississippi Delta are strongly influenced by the fresh water outflow from the river. At Head-of-Passes the Mississippi River branches into three major channels: Pass-A-Loutre, transporting 37% of total river discharge; South Pass, 29%, and Southwest Pass, 15%. Fresh water discharge rates vary seasonally with highest values occurring during the spring; lowest in the fall. Outflow from the Mississippi Delta maintains its general integrity as it passes over the more dense, saline underlayer. Scruton (1956)

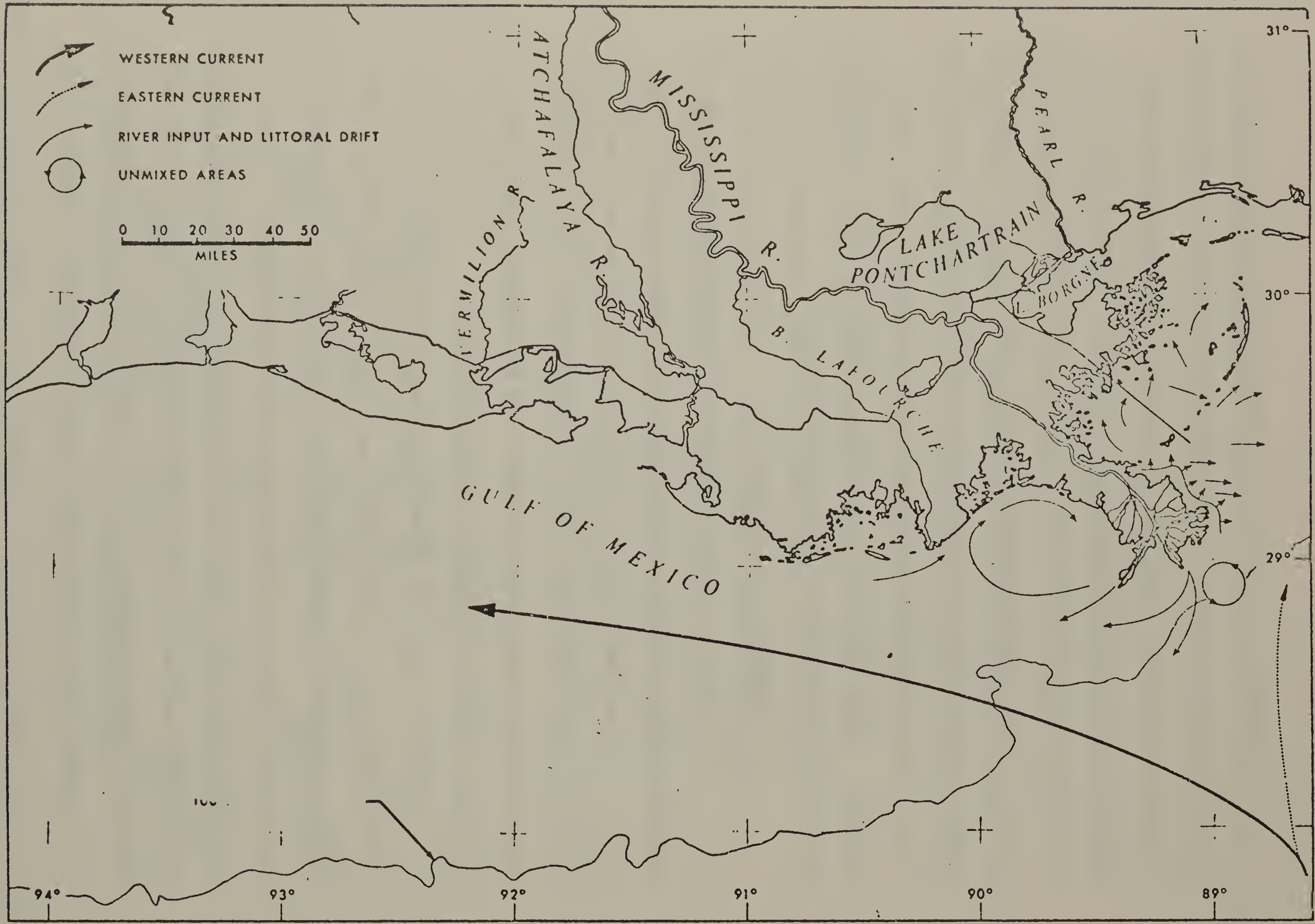



Figure 13 Generalized surface circulation along the Louisiana continental shelf (from Stone, 1972).

observed a fresh water plume extending 20 miles off Pass-a-Loutre. This has been confirmed by Eleuterius (1974) whose data indicates that at times this plume extends some forty miles eastward. Fresh water plumes to the south and west are less well known, however, they undoubtedly exert considerable influence.

After sweeping westward along the Louisiana continental shelf prevailing surface currents turn southwestward, roughly paralleling the Texas coast. Another surface current system moves northward along the Mexican coast to a zone of convergence off Texas. The actual area in which the north and south moving currents converge changes throughout the year in response to atmospheric conditions. In winter the area is to the south of the U. S. - Mexican border. The area shifts gradually northward during the spring and summer months. Current velocities range in speed from about 0.4 to 1.5 knots.

c. Bottom circulation

Little is known about bottom circulation in the Gulf of Mexico. Bottom current measurements although feasible are so rare that circulation patterns can not be described. Reports from divers indicate that bottom currents can be strong enough to make diving hazardous and mobility in some areas difficult. Thus controversies rage as to the size (shape and height) of drill cutting cones around platforms. Photographs exist showing drill cutting cones of various sizes and positions around platforms (Setlow, 1975). In the Middle Grounds bottom currents were reported to have swept most

of the drill cutting out of the area (Johnston, 1975, Personal communication). Bottom circulation studies are being planned for pipeline management studies for the Gulf of Mexico. Shelf circulation studies in co-ordination with deep basin circulation studies is proposed in the MAFLA Oceanographic Data Report under BLM Contract No. 08550-CT4-L6, 1974.

2. <u>Sea Surface Temperatures</u>

Leipper (1954a) presents data for average sea surface temperature for the Gulf of Mexico. According to Leipper, the main feature of the average winter pattern is a gradual drop from approximately 75°F in the south to 65°F in the north in all parts of the Gulf. In the summertime, average temperatures are very nearly uniform at 84°F throughout the Gulf. Years of investigations have shown that considerable deviation from these average isotherms may occur at certain times.

3. <u>Tides</u>

The tides of the Gulf of Mexico are weakly developed and usually their observed range does not exceed 0.7 meters (Durham and Reid, 1967). Semidiurnal (twice daily) tides are small, and therefore, overall tides in the Gulf are considered diurnal (daily) in character. In 1897, R. A. Harris (in Grace, 1932) suggests that the diurnal tides of the Atlantic Ocean influences the tides in the Gulf through the Yucatan Channel. Later in 1900, he expressed the opinion that a single oscillating system with a nodal line extending from western Haiti to Nicaragua is formed by the Gulf of Mexico and the Caribbean Sea. This would cause the tides of the Gulf to be simultaneous. In 1908, Endros (in Grace,1932) arrived at a similar conclusion considering the Gulf and the Caribbean Sea to be a single oscillating body with a period of nearly 24 hours. Tidal regimes have been shown for the Gulf of Mexico as displayed by Eleuterius (1974)in Figure 14 .


**FIGURE 14 GULF OF MEXICO TIDAL REGIMES.** From Eleuterius, C. K. 1974. Mississippi Superport Study, Environmental Assessment.

In 1908, G. Wegmann (in Defaunt, 1961), considered the reasonance effect of the diurnal components of the Gulf and found the period of free oscillation for an east-west oscillation to be 24.8 hours. According to work by S. F. Grace (1932) the diurnal tide enters through the Florida Straits, progresses counterclockwise around the basin, is reflected by the northwestern and southern coasts and egressed through the Yucatan Channel.

When the moon is near its maximum declination, the tide is diurnal and has the greatest range. When the moon is over the equator, the tide has the least range and there may be several days having two highs and two lows. Although tides in the Gulf have a small range they do have important roles in modifying currents and accelerating the movement of water through narrow passages.

4. Sea, Wind, Waves and Swell

When wind speeds exceed two knots, waves are generated in the vicinity of the wind. Winds of increasing velocity create progressively higher waves. Swell is the term applied to the generally long period waves which have been generated by winds in areas some distance from the area of reference.

Wind speeds prevalent in the Gulf are responsible for waves which have a mean height of three to four feet.

Higher wave heights occur during the period of November, December, January, February, and March when stronger winds blow out of the north. Prevailing winds during spring, summer, and early fall are from the southeast and wave heights are generally less during this

period. Waves associated with storms range considerably higher. During hurricane "Camille" in 1969, for example, waves 70 feet high were reported offshore, with winds exceeding 200 miles per hour.

Due to the coriolis effect sea breezes rotate clockwise in the northern hemisphere during a 24 hour period. Usually the sea breeze will start around 1000 hours, reach a maximum at 1400 hours and afterwards be replaced by the nocturnal land breezes. To answer questions on amplitude phase and frequency of responding waves, currents and beach erosion and deposition a fully instrumented project was undertaken on Santa Rosa Island Florida by Sonu, et al. (1973). Their results demonstrated that sea breeze significantly affected the dynamic processes operating on the coast in the following summary:

(1) Meteorological parameters such as aerodynamic roughness, shear stress, and atmospheric stability exhibited definite coupling with the wind speed. A new relationship between the friction velocity and the wind speed at 10 meters was found; this new relationship contrasts with conventional deepwater expressions. The aerodynamic roughness depended not only on waves, as was expected, but also on atmospheric stability mainly associated with land breeze.

(2) The sea breeze produced a high-frequency peak in the nearshore wave spectrum that dominated the background swell in the afternoon and evening. The response of the wind waves involved amplitude, frequency, and direction, whereas that of the swell was primarily limited to amplitude.

(3) Nearshore currents responded with a lag of 3-5 hours to the onset of the sea breeze cycle with current amplitudes of up to 25 cm/sec. As a consequence of the proximity of the coast and the surface slope associated with wind setup, these currents flowed essentially parallel to the shoreline and had only minor onshore-offshore components.

(4) Wave-induced currents around and inside the inner bar underwent systematic diurnal variations in response to offshore wave breaking and incidence angles of the diurnal wave field, changing from closed circulations (early afternoon), to meandering currents (late afternoon), to weakly curved parallel currents (night and early morning).

(5) The beach system acted as a low-pass filter to input waves, so that both swash and groundwater fluctuations underwent high-frequency attenuation. The cutoff frequency varied as a function of the combined effects of the tide and diurnal wave field.

(6) Topographic response exhibited dependence on the scale of topography and excitation frequency. Whereas small-scale features such as ripples, megaripples, and beach cusps changed within an hourly or shorter time scale, large features such as crescentic bars and rhythmic shorelines on the order of 120 meters in wavelength remained unresponsive for over three weeks.

## D. Chemical Oceanography

### 1. Nutrients

Nutrients can be defined as the substances that are needed for marine life to reproduce and grow. In the marine ecosystem phytoplankton constitutes the primary producers and as such are dependent on an adequate supply of three essential nutrients: nitrogen, phosphorous and silica.

The primary sources of supply of these nutrients are upwelling of deep waters, advection and discharge from land sources (rivers and industrial and domestic sewerage). The primary process depleting the concentration of nutrients in the surface waters is rapid uptake by phytoplankton and consequent removal of the phytoplankton by predation or by sinking. As a result, only low concentrations of nutrients are normally found in surface waters except in local source areas.

Major source areas of turbidities are the rivers and bay outlets into the Gulf of Mexico, principally the Mississippi and Rio Grande rivers. Organic content of the waters are high bordering south Louisiana and Texas. A nutrient analyses of waters in the eastern Gulf of Mexico have recently been completed for the MAFLA baseline study, Fanning (1974). He reports on five of the most common dissolved nutrients (nitrate, nitrite, silica, phosphate and arsenate). Results show low surface and intermediate values and highly bottom enrichment. Fanning (1974) rejects upwelling as the cause of the bottom enrichment and favors this enrichment from release of the nutrients

from bottom sediments through diffusion or seepage. Manheim (1974, Appendix E) also points out that the intermediate and surface nutrient values could also be caused by uptake by benthic algae.

2. Salinity

The salinity patterns of the Gulf of Mexico (Fig. 15) are principally determined by: inflow of ocean waters through the Yucatan Strait, precipitation and inflow of fresh water from land sources, evaporation,

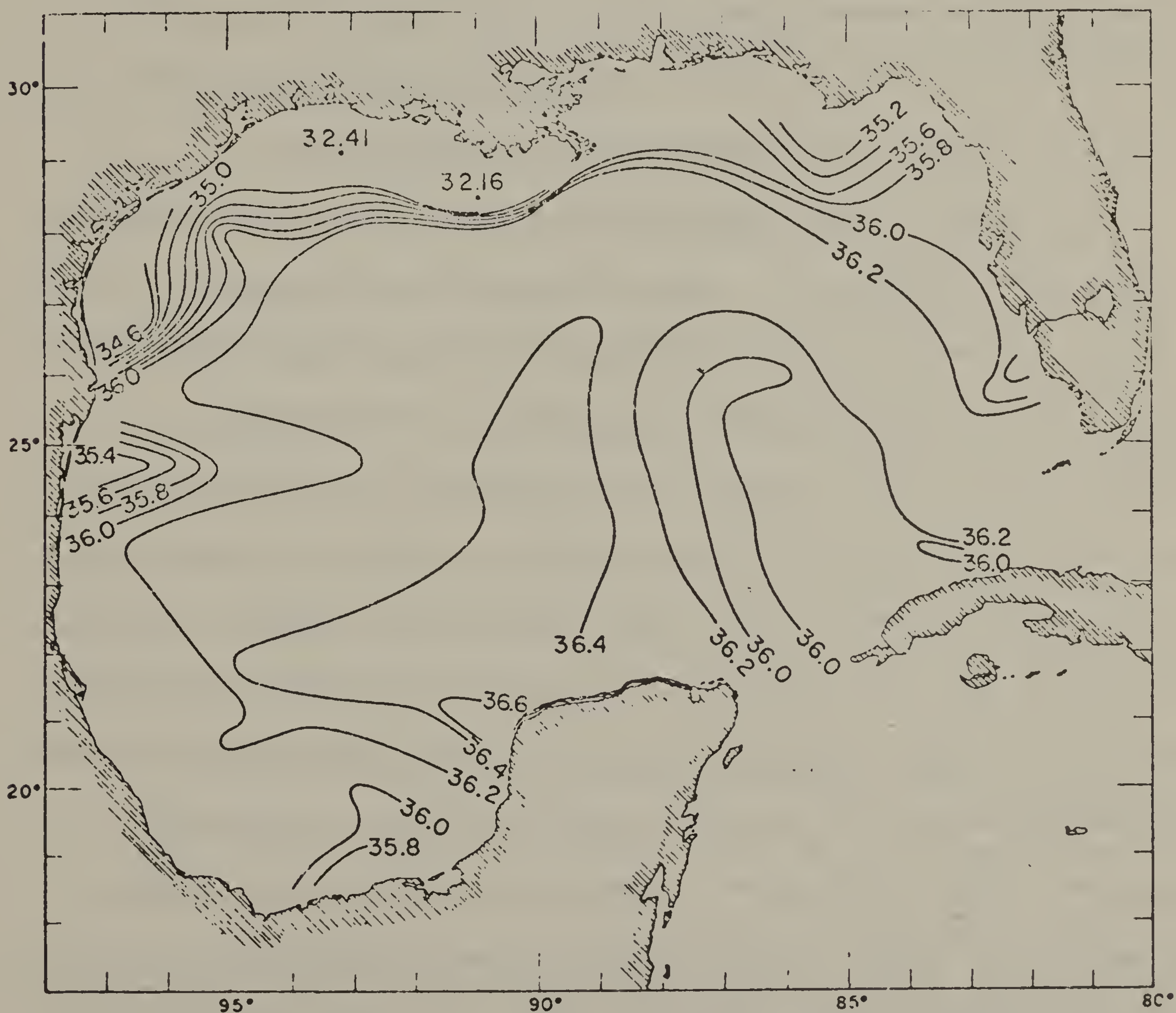



Figure 15. Typical surface salinities (parts per thousand) in the Gulf of Mexico (Nolin, 1972).

circulation and mixing and outflow through the Straits of Florida. In the northern Gulf runoff from the Mississippi, Atchafalaya and from smaller rivers to the east and west gives rise to a band of low-salinity water (Nolan 1972).

3. Trace Metals

The trace metals that usually occur in the marine environment include cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, iron, uranium and zinc. These occur in concentrations normally less than one part per million (1 ppm.) These metals can enter the marine environment through weathering of rocks or by pollution discharge of human development.

Trace metals determinations in the Gulf of Mexico are summarized by Segar (1974 Appendix E). A map of trace metals in Gulf of Mexico sediments by Holmes (1973) agrees with the low concentration found on the west Florida shelf by the Mafla investigators, (Presley et al., 1974). Analysis were attempted for several of the toxic heavy metals such as barium (present in barite drilling muds), nickle, vanadium, lead, copper, iron, cadmium and chromium. Similar trace metals were also measured in the water by the MAFLA researchers. These values should be supplemented by work from Slowey and Hood (1969) who analyzed samples in the Gulf of Mexico for zinc, copper and manganese. These findings are comparable to those by Hood (1963) and Rona, et al. (1962). Moritus (1961) showed values of copper much lower than those by Slowey and Hood (1969). In these studies it was found that coastal waters have an order of magnitude greater concentration than open ocean waters.

A most intensive study of trace metals in the Gulf was completed by Corcoran (1972) for six trace metals, Cd, Pb, Cu, Cr, Zn and Mg. Except for copper, the concentration of the five other metals was 10 times the concentrations typically observed in open ocean waters. Also manganese was higher than concentrations reported by Rona,et al. (1962). This seems to indicate enrichment of trace metals by the Mississippi River and from Escambia, Perdido and Mobile bays. The most complete data on Alabama's coastal area was compiled by May (1973) from water samples collected in Mobile Bay and in Gulf waters within six miles of offshore Alabama.

When adequately sampled it appears that trace metal data can complement or reinforce circulation information and can indicate dynamic characteristics. Evidence of this is discussed in A Summary of Knowledge of the Eastern Gulf of Mexico (Jones et al., 1973) as follows:

An examination of the distribution of trace metals in the ESCAROSA area indicates that water movements are complex. There seems to be a general movement of surface waters from west to east, while the bottom waters appear to move from east to west. Salinity, silicate, and manganese data indicate a surface flow of water out of the bays, yet the trace metal data show an offshore enrichment with no apparent surface connection. This would indicate that the trace metals are carried below the surface upon their entrance into the Gulf, only to rise again a few miles away in small divergent areas, or they are entrapped within the bays and their offshore enrichment comes from the Mobile Bay and Mississippi River sources, or the surface waters are enriched by wind-carried aerosols. Possibly all three processess contribute.

Sediment studies seem to indicate bay entrapment, but it is also well known that trace metals are released from sedimentary particles upon contact with saline water, and it is also well known that trace metals (especially lead) are constituents of the aerosols.

Slowey and Hood (1969) have reported high trace metal content at intermediate depths in Gulf water. They found this metal content at intermediate depths to decrease as the water moved through the Gulf of Mexico and concluded the metal origin to be from outside the Gulf, either from residual subantarctic intermediate water, or from continual rain of decaying organisms with their resultant release of metals during the northward transit of the water. The outside origin of high metal content of intermediate water seems reasonable and feasible. However, the conclusion is based on the resemblance of copper, manganese and zinc distributions in the Gulf to these found at one station taken from north of Cuba. A complete study of the distribution of trace metals with special attention given to the contributions through the Straits of Yucatan, from the Mississippi River, Mobile Bay, etc., would be most worthwhile and enlightening.

A map of trace metals for the Gulf of Mexico sediments has been proposed by Holmes (1973) from a semiquantitative analysis of sediment samples taken mainly from NMFS Geronimo Cruises by John Grady's sediment sampling project. Holmes (1971) has prepared a detail map of Zirconium distribution in the northwestern Gulf from Galveston to beyond the Flower Garden Banks, Figure 16. His analyses indicate that the highest trace-element concentrations are in regions of the shelf

that are actively receiving sediments. The zirconium concentrations are an exception because they are deposited in areas of slow deposition along the elongate bathymetric features in offshore Texas. This correlation of zirconlum concentration to the elongated features suggests that the topographic features are ancient shorelines that have been submerged during the past Pleistocene rise in sea level.

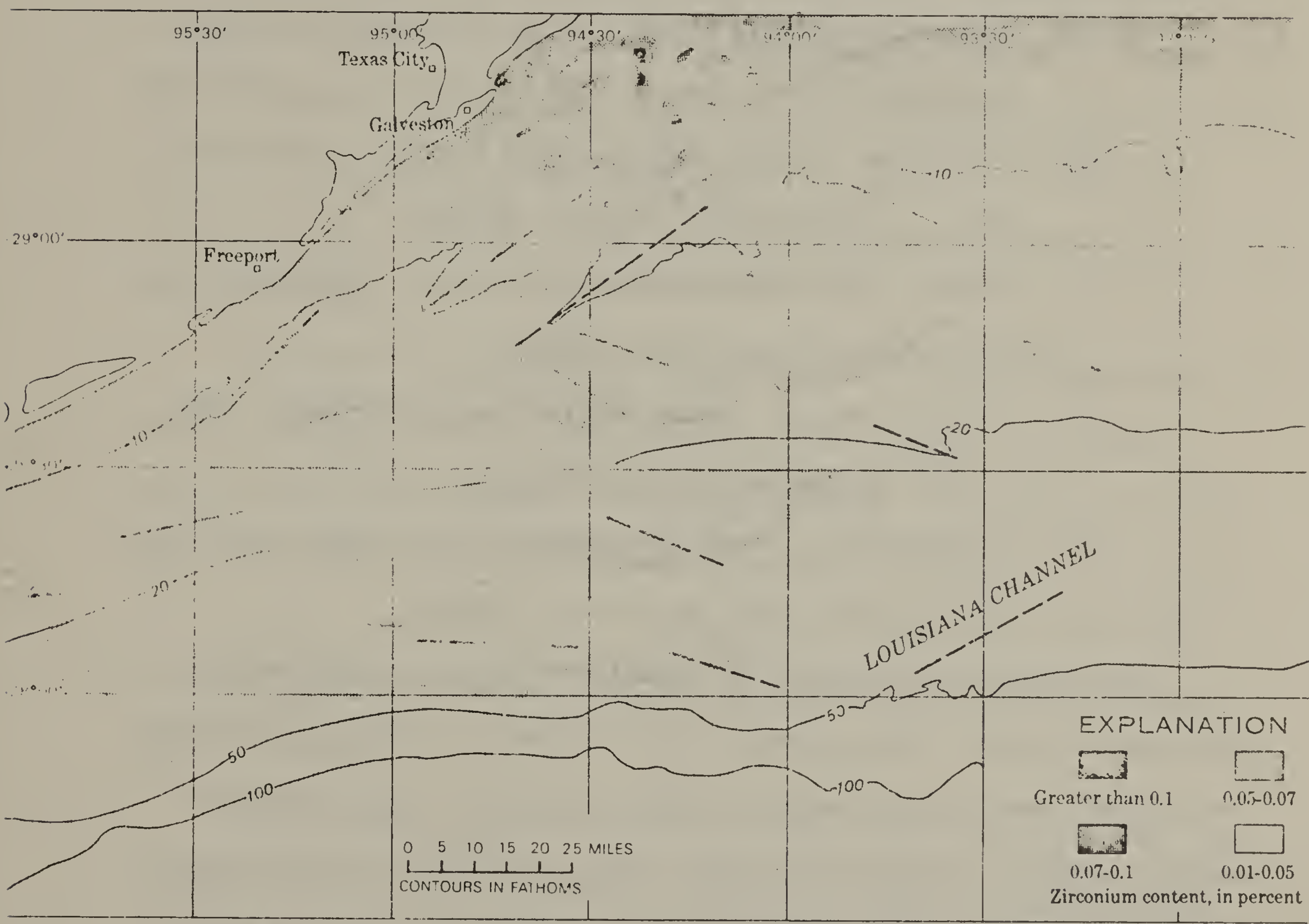



Figure 16 Distribution of zirconium in the central part of the northwest Gulf of Mexico shelf. Dashed lines approximate the axes of the topographic ridge

From Charles W. Holmes, Geological Survey Research Papers, 1971.

## E. Biological Oceanography

Considerable data are available concerning the biology of the Gulf of Mexico. Previous environmental statements prepared by the Bureau of Land Management have treated this subject in detail. Reference to the following environmental statements is suggested for a more detailed discussion on the biology of the offshore environment for this proposed sale area.

(1) Mississippi and Alabama - Final Environmental Statement, FES 73-60, Vol. 1, OCS Sale No. 32, pp. 162-184.

(2) Louisiana - Final Environmental Statement, FES 74-41, Vol. 1, OCS Sale No. 36, pp. 199-226.

(3) Texas - Final Environmental Statement, FES 74-63, Vol. 1, OCS Sale No. 37, pp. 176-196.

(4) Gulf of Mexico - Draft Environmental Statement, DES 74-90, Programmatic, pp. 328-351.

(5) Central Gulf, Final Environmental Statement, FES 75-37, Vol. 1, OCS Sales No. 38, pp. 53-68.

The offshore environment is broadly divided into the pelagic and benthic realms. The pelagic realm includes all ocean water above the bottom; over the continental shelf, the waters constitute the neritic province (as opposed to the oceanic province above the slope and deep ocean bottom). The biota of the pelagic division is generally subdivided into plankton (organisms that float or drift in the water), and nekton (organisms that are active swimmers). The benthic division includes the sea bottom and sub-bottom environment and its

biota is called benthos.

1. Plankton

a. Zooplankton

According to Bogorov, et al., (1968) the distribution of zooplankton for the Gulf of Mexico is less than 50 $mg/m^3$. In addition, Khromov (1965) studied the quantitative distribution of zooplankton biomass in the northwest Caribbean Sea and most of the Gulf of Mexico, and indicated a zone of low zooplankton density ($0.5g/m^3$) east of Galveston, southwest of Galveston the nearshore density exceeded $0.5g/m^3$ in the shallow coastal waters, with lower densities seaward.

The most important grazers (herbivores: organisms which rely chiefly on vegetation for their food) are the copepod crustaceans, which are the most abundant zooplanktonic group in any given plankton sample (Raymont, 1963). Where phytoplankton populations become abundant, copepod populations will also flourish after a lag period of growth of young and immature stages, and their eventual second generation spawning.

Common copepod species found in neritic Gulf waters include the calanoid copepods *Euchaeta marina*, *Neocalanus gracilis*, *Scolecithrix dana*, *Candacea pachydactyla*, *Unidinula vulgaris*, *Eucalanus attenuata* and *Acartia tonsa*, as well as the cyclopis copepods *Copilia mirabilis* and *Corycaeus* spp. *Euchaeta* and *Corycaeus* differ from the rest in being carnivorous (organisms which depend chiefly or solely upon

catching animals for their food). Acartia tonsa is a dominant near-shore form in bays and estuaries, and is found less commonly offshore (Gillespie, 1971).

Euphausiid crustaceans are also prominent members of the zooplankton assemblage. Major species found in the Gulf are Euphausia americana, E. mutica, E. brevis and Stylocheiron carinatum. Feeding habits of euphausiids have variously been described as herbivorous, carnivorous and detritivorous (organisms which feed chiefly or solely on organic or inorganic particulate debris). While some, e.g. Euphausia superba in the Antarctic, appear to be strictly herbivorous, it seems best to conclude that euphausiid species are at different trophic levels or each species has a range of organic material from which to satisfy nutritional requirements (Raymont, 1963).

Possibly the most significant carnivores in the zooplankton are the chaetognaths (arrow worms). Copepods dominate their diet but this may be an artifact based on relatively high copepod abundance (Raymont, 1963). They also feed on fish and barnacle larvae. The genus Sagitta is common worldwide; Gulf species include S. setosa, Pterosagitta sp., Krohnitta sp. and Eukrohina sp.

Other common carnivores in the zooplankton include the ctenophores (Pleurobrachia and Beroe), medusae of various species, ostracods, cladocerans (Podon and Evadne), mysid and amphipod crustaceans, heteropods (Atlanta leseuri), pteropods, salps and pyrosomes. Another significant group of carnivores are the various larval and immature forms, both holoplanktonic (planktonic at all stages of its life cycle)

and meroplanktonic (organsism which have planktonic reproductive stages), from several phyla. These include most of the crustaceans mentioned, the tunicates, echinoderms, cephalopods, ectoprocts, sponges, annelid and nemertedn worms. Fisheries larvae are important carnivores, and the survival of larvae of commercial fish has an obvious economic impact.

Hopkins (1973) summarized data for zooplankton of the eastern Gulf and stated that:

(1) The principal hydrographic factors regulating zooplankton distribution in the eastern Gulf of Mexico are the Loop Current, Mississippi River, and local runoff into Gulf coastal areas.

(2) The copepod Acartia tonsa is the principal plankton species in terms of biomass in estuaries of the eastern Gulf.

(3) Zooplankton diversity in Gulf coast estuaries increases with increasing salinity.

(4) Meroplankton constitutes a significant portion of the zooplankton biomass in estuaries, especially during the summer months.

(5) Zooplankton diversity in east Gulf coast estuaries is generally greater in summer than in winter.

(6) One of the principal regulators of seasonal patterns of zooplankton in Gulf coast estuaries may be predators such as ctenophores and scyphomedusae which graze heavily on the plankton population in winter.

(7) Zooplankton biomass ranges from 0.08 to 0.80 $ml/m^3$ in an estuary (St. Andrew Bay data x 10 to convert from dry weight to volume), 0.02 to 0.10 $ml/m^3$ in shelf waters, and 0.01 to 0.10 $ml/m^3$ in the east central Gulf. In local areas of the shelf standing crop can be as high as 3.0 to 8.0 $ml/m^3$.

(8) Zooplankton biomass appears to reach a maximum in eastern Gulf estuaries and on the southwest section of the Florida shelf in summer and on the northeastern shelf and central Gulf in winter. No significant seasonal changes in biomass

seem to occur within the Loop Current.

(9) Upwelling generated by the Loop Current is responsible for the summer biomass maximum on the southwestern Florida shelf while river discharge and cool meteorological conditions are primarily responsible for the winter peak on the northern Gulf shelf.

James, et al. (1972) extrapolated from the taxonomic studies of the eastern Gulf and the few Texas zooplankton collections which have been examined, and concluded that Texas shelf waters are quite rich in the same zooplankton species found elsewhere in the Gulf, with representatives from many diverse biotic groups. Some of the more common and important members include the copepods, euphausiids, medusae jellyfish, ctenophores, mysids, chaetognaths, planktonic larval shrimp, crab larvae, pteropod and heteropod molluscs, worms, salps and pyrosomes. Protozoans (one cell animals) such as foraminiferans and radioloarians may be locally abundant.

b. Phytoplankton

El Sayed (1972) used measurements of chlorophyll a (a bluish black pigment found in phytoplankton) to calculate estimates of the phytoplankton standing crop (total number or weight of living organisms momemtarily present in an environmental unit; Pennak, 1964) for the Gulf of Mexico. Surface chlorophyll a showed higher concentrations (high standing crop) during the winter than at any other season; these were followed by a decrease in the standing crop of phytoplankton during spring, and a gradual increase in summer and fall. In terms of chlorophyll a (sea-surface values and data integrated for the euphotic zone), the Gulf of Mexico is no different from other tropical

or sub-tropical bodies.

The levels of gross primary production (total quantity of green plant protoplasm produced per unit time in a specific habitat) in different geographic localities in the Gulf of Mexico resemble the distribution of the phytoplankton standing crop. As with chlorophyll a, the surface and integrated (with the euphotic zone) primary productivity values in the inshore water (0.55mg $C/m^3/hr$ and 7.04mg $C/m^2/hr$ respectively) were higher than those values for offshore waters (0.21mg $C/m^3/hr$ and 5.45mg $C/m^2/hr$). The average primary productivity of the Gulf was 0.15 g $C/m^2/day$ (El Sayed, 1972).

Simmons and Thomas (1962) sampled phytoplankton from the eastern Mississippi Delta and described two assemblages associated with different salinity regimes. A low salinity regime of river water has an assemblage dominated by two species each of the genera Cyclotella, Melosira and Navicula. A higher salinity regime of Gulf waters had an assemblage composed of Nitzschia seriata, Thalassiothrix frauenfeldii, Thalassionema nitzochioides, Skeletonema costatum, Asterionella japonica and three species of Chaetoceros. This Gulf water regime near the fresh water plume has higher diversity due to mixing of fresh water and marine genera. Seasonality of species (presence and abundance) was more variable in the Gulf regime than in the river regime. In both areas, the lowest abundances (standing crop) were noted in November. Dinoflagellates were minor constituents of the phytoplankton observed near the delta (op. cit.). Widespread, but nowhere

abundant, genera included _Ceratium_, _Glenodinium_, _Goniodoma_, _Phrocistis_, _Hypodinium_, _Gymnodinium_, _Gloedinium_, _Peridinium_, _Hemidinium_ and _Dinophysis_.

Sanders and Fryxell (1972) plotted the distributions in the Gulf of 14 diatom species. The 14 species were selected on the bases of: frequency of occurrence, ease of identification, sufficient size to be retained in net collections and interesting relationship to environmental influences. The group included two species each of the genera _Chaetoceros_, _Hemiaulus_, _Biddulphis_, _Hemidiscus_ and _Rhizosolonia_, and one species each of _Guinardia_, _Thallassionema_, _Certaulina_ and _Asterionella_. _Rhizosolenia alata_ was the most frequently observed species over the entire Gulf, and is found during 11 months of the year. _Guinardia flaccida_ is also found in all months, and in most months _Chaetoceros compressum_, _C. peruvianum_, _Hemiaulus membranaceus_ and _Rhizosolonia stolterfothii_ can be found (Balech, 1967).

Dinoflagellate distribution was reviewed by Steidinger (1973) who mapped occurrences of 14 frequently found species in the Gulf. Species diversity of dinoflagellates was found to be higher offshore (where it occasionally exceeds diatom diversity) than nearshore, while dinoflagellate abundance was higher nearshore than offshore.

The open Gulf phytoplankton assemblage includes the diatom genera _Gossleriella_, _Ethmodiscus_ and _Planktoniella_, and the dinoflagellate genera _Teiposolenia_, _Heterodinium_ _Amphisolenia_, _Murrayella_, _Histioneis_, _Ptychodiscus_, _Cladopyxis_, _Kofoidinium_, certain _Ceratium_ spp. and _Pyrocystis_, according to Steidinger (1973). While the dinoflagellates are more diverse in this area, they do not necessarily dominate the

standing crop.

Steidinger (1973) summarized data for phytoplankton of the eastern Gulf and stated that:

(1) Problems in plankton methodology are briefly outlined and their implications in data interpretation discussed, e.g., it is difficult to make geographic comparisons without standard methods, what methods are currently available may not be accurate, and the estimates derived should be used with caution, particularly in fisheries harvest projections.

(2) There appear to be four types of phytoplankton distribution: estuarine, estuarine/coastal, coastal/open Gulf and open Gulf with diatom and dinoflagellate species characteristic of each category.

(3) Species and composition is of year-round resident coastal species that fluctuate in dominance and secondarily of what has been called "visitors". Periods of seasonal peaks vary year to year and area to area. Studies to date in eastern Gulf of Mexico waters indicate that succession and seasonality are difficult to interpret but maximum production is in spring and summer.

(4) Data indicate that diatoms (species diversity and abundance) dominate inshore coastal areas while dinoflagellates, particularly species diversity, can often dominate open Gulf waters.

(5) It is important in all species composition evaluations to realize that even though diatoms and dinoflagellates are used as indices because of their identifiable nature, microflagellates (5-15 $\mu$) numerically dominate in eastern Gulf coastal and estuarine environments. These microflagellates are rarely identified to species.

(6) Primary production and Chl a maxima in open Gulf and shelf waters are not surface bound, they are at lower depths.

(7) Areas of upwelling or river drainage are the most productive and the least productive are open Gulf waters not influenced substantially by these parameters. Eastern Gulf of Mexico estuaries, particularly Tampa Bay, have higher primary productivity and standing

crop than many temperate or tropical counterparts while coastal and open Gulf waters are comparable to nutrient rich tropical waters but lower than similar temperate regimes.

(8) Various phytoplankton researchers have mentioned that the eastern Gulf of Mexico needs further study with more sampling, preferably synaptic. Most data are derived from stations occupied too infrequently or only once.

(9) The basic known ecology of red tides is outlined and suggestes that Gymnodinium breve, the causative organism, blooms annually in selected parts of coastal Gulf waters, but that many inter-related parameters must be optimal for the bloom to be supported and develop into a major red tide outbreak.

(10) Nutrients, particularly chelated trace metals, have been implicated with the initiation of red tides in Florida waters following heavy rainfall and land run-off. Using iron as an index, researchers suggest that monitoring of certain river discharges can be used to predict major red tides.

(11) Red tides appear to have their severest effects on local and state economy in the form of reduced tourism and the expense of dead fish removal. Commercial fisheries are reportedly not affected while isolated sports fisheries, i.e., reef fishing, are affected in a red tide area.

(12) Controlling Gymonodinium breve red tides after they have developed is considered unfeasible at the present time for reasons outlined in the text, e.g., vast area and volume of saltwater to be treated as well as the prospect of recruitment of other G. breve populations by physical forces from surrounding areas. Gymnodinium breve blooms are not a surface phenomenon and the organism can be found throughout the euphotic zone. Presently, red tide research continues and covers such salient points as life history of the causative organism and varying degrees of susceptibility among different fishes and invertebrates.

Graphic representation of the Gulf of Mexico phytoplankton production (mg $C/m^2/d$) may be found under general Gulf, Graphic 3, Vol. 3.

This data was taken from Koblentz et al. (1969). In addition this graphic depicts data for benthic algae and seagrasses for the Gulf.

c. Summary

El-Sayed, Hopkins and Steidinger (1974) summarized the state of knowledge of phytoplankton/zooplankton investigations off the west coast of Florida (Table 2), and in the northeastern Gulf (Table 3).

Additional description and data on phytoplankton, sargassum and zooplankton for five discrete tract areas in the MAFLA (Mississippi-Alabama-Florida) shelf areas of the eastern Gulf of Mexico, extending from approximately 89°W, south of Pascagoula, Mississippi, to a tract west of Clearwater, off Tampa Bay, Florida, may be found in Appendix E. This survey was conducted by the State University System of Florida Institute of Oceanography Consortium for the Bureau of Land Management prior to oil and gas operations for the MAFLA area as a result of lease sale No. 32.

Table 2

Summary of State of Knowledge of Phytoplankton/Zooplankton Investigations off West Coast of Florida

| | Excellent | Good | Fair | Poor | Remarks/Needs |
|---|---|---|---|---|---|
| Solar Radiation/ Light Penetration | | | | X | Badly needed for primary productivity studies. |
| Phytoplankton Standing Crop | | | X | | Need for more geographical and depth studies. |
| Primary Production | | | X | | |
| Nanoplankton | | | | X | Significance in primary productivity should be assessed. |
| Diatoms (Species Composition) | | X | | | Endemic vs 'visitors' (Caribbean) should be determined. |
| Dinoflagellates (Species Composition) | | X | | | |
| Seasonal Studies | | | | X | Need to study seasonal succession; seasonal variations in productivity parameters and nutrients. |
| Inorganic Nutrients | | | X | | Rates of uptake and regeneration of these nutrients are totally lacking. |
| P.O.C. and D.O.C. | | | | X | |
| Vitamins and Trace Elements | | | | X | |
| Relation to Hydrography | | | | X | Future studies should emphasize influence of Loop Current, River Discharge, etc. |
| Phytoplankton/Zooplankton Relationship | | | | X | An almost untouched field. |
| Zooplankton Standing Crop | | | | X | Badly needed data |
| Species Composition/ diversity | | | X | | |
| Metabolic Studies, Estimation of Secondary Production | | | | X | |

Table 3

Summary of State of Knowledge of Phytoplankton/Zooplankton Investigations in Northeastern Gulf of Mexico

| | Excellent | Good | Fair | Poor | Remarks/Needs |
|---|---|---|---|---|---|
| Solar Radiation/ Light Penetration | | | X | | |
| Phytoplankton Standing Crop | X | | | | Data on hand can be used as baseline data. |
| Primary Production | | X | | | |
| Nanoplankton | | | | X | Significance in productivity should be assessed. |
| Diatoms (Species Composition) | | X | | | |
| Dinoflagellates (Species Composition) | | X | | | |
| Seasonal Studies | | X | | | Monthly observations available between May 1964--April 1966. |
| Inorganic Nutrients | | X | | | |
| P.O.C. and D.O.C. Vitamins and Trace Elements | | | | X | |
| Relation to Hydrography | | | X | | Effect of Loop Current, Miss. discharge should be studied. |
| Phytoplankton/ zooplankton Relationship | | | | X | Feeding selectivity and contributions of grazers to nutrient regeneration should be studied. |
| Zooplankton Standing Crop | | | | X | Badly needed data. |
| Species Composition/ Diversity | | | | X | |
| Metabolic Studies, Estimation of Secondary Production | | | | X | |

2. Benthos

The benthic communities for the OCS can be broadly described as shallow, intermediate and deep shelf assemblages, and slope assemblages. Within these broad areas, more specific assemblages can be described for shrimp grounds, oyster grounds, sand bottoms, silt and mud bottoms, rocky bottoms and hard banks. For location of these bottom types see the following visual graphics:

(a). Bottom sediments - western, central and eastern Gulf, Graphic 3, Vol. 3.

(b). Undersea features - western, central and eastern Gulf, Graphic 4, Vol. 3.

(c). Coastal zone and offshore fisheries - western, central and eastern Gulf, Graphic 5, Vol. 3.

(d). Migration of Gulf of Mexico penaeid shrimp and main fishing grounds - general Gulf, Graphic 5, Vol. 3.

Lyons and Collard (1974) reported on the offshore benthic community of the eastern Gulf of Mexico. Their data provides a detailed, concise treatment of this environment and is presented in part below:

West Florida Shelf

The following delineations (Figure 17) are based upon observed faunal variation in more than 700 dredge and trawl tows from the Hourglass program (Florida Department of Natural Resources), supplemented by many comparable collections and some scuba observation in other areas of the shelf. The degree of faunal change is the criterion used for suggesting separations. Obviously, each zone intergrades

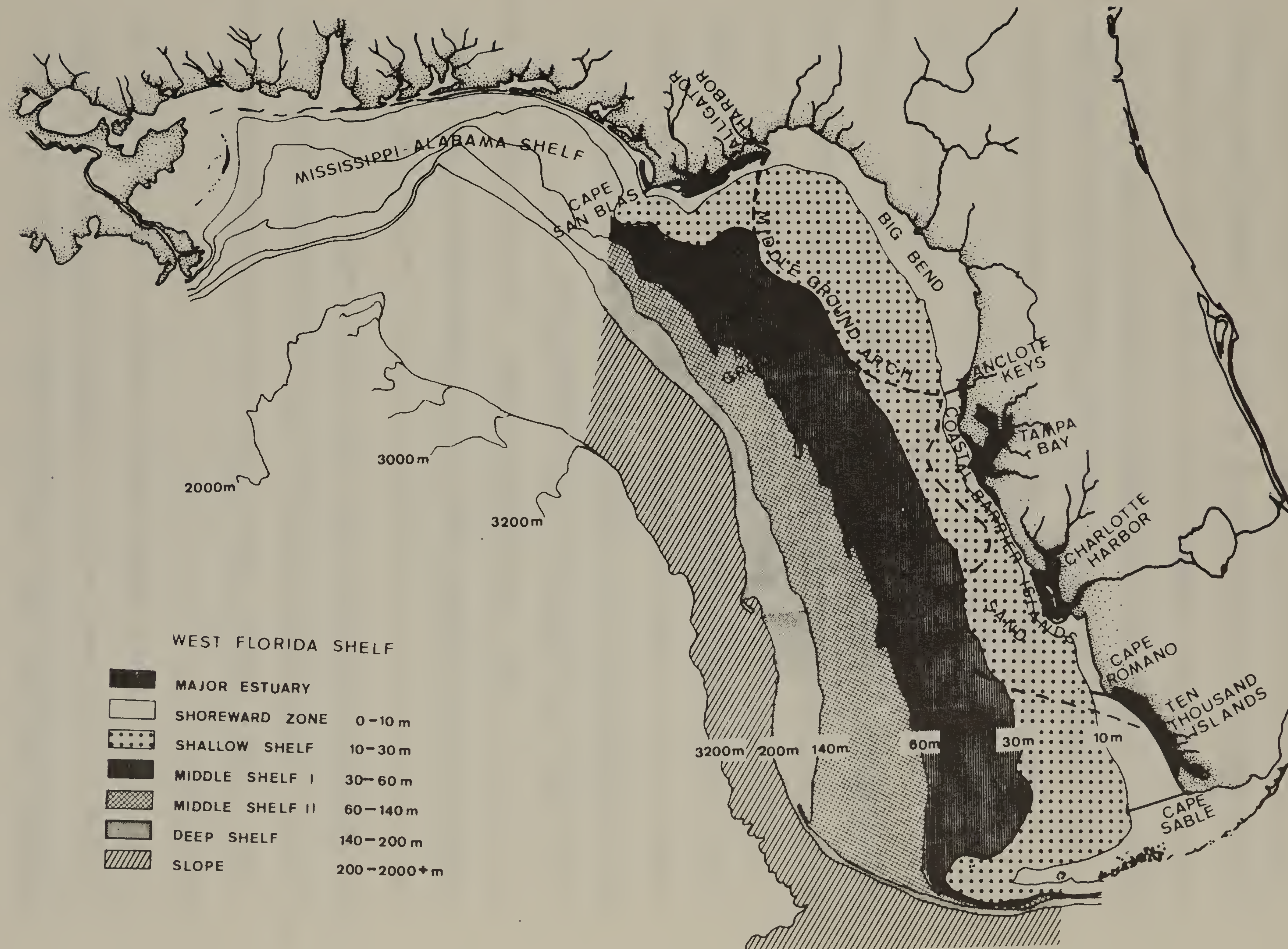



Figure 17 Source: Lyons and Collard (1974)

into its neighbors without sharply defined boundaries, and areas if intergradation are difficult to categorize. Nevertheless, central areas of these zones seem distinctive. Geological and hydrological features coincident with the zones are suggested as basic factors of community composition. Suggested depths for each zone are mean estimates; these depth limits may vary somewhat in response to geologic and hydrographic variation.

(1) Shoreward Zone (0-10m): This zone is defined as the area extending from the land-water interface to depths of approximately 10 m. The latter is the mean depth where rocky outcrops become important substrate elements along much of the Florida west coast. Salinities fluctuate several parts per thousand in response to runoff from nearby rivers and bays. Temperature variations are nearly as severe as in adjacent estuaries. Nutrients are generally quite high. Four subdivisions are proposed for the shoreward zone.

(a) Ten Thousand Islands: Extending northward from Cape Sable to Cape Romano, this area is characterized by grass beds and scattered sand bottom blending the mangrove estuary smoothly into the offshore rocky communities. Many shallow water tropical species from the Keys occur here especially in grassy portions, but many temperate species are also common, especially in sand communities. Beaches are scarce.

(b) Coastal Barrier Islands: Moderate wave energy beaches of quartz sand and shell fragments are the dominant shoreward feature of this zone which extends northward to Anclote Key. Bottom

composition is also largely of these materials, with little hard substrate except dead shells of large mollusks. Seagrasses are scarce to absent. The quartz-shell sediments actually extend far to sea off Tampa Bay and the Charlotte Harbor area. In the latter area, influence of these sediments is quite strong in the next seaward zone, and possibly even beyond. Large temperate mollusks and echinoderms are characteristic faunal elements. Species diversity is generally lower than in adjacent estuaries or offshore areas.

(c) Big Bend Area: This may be best defined as a huge, seagoing estuary extending from near Anclote Key to the vicinity of Alligator Harbor, Oyster reefs are common parallel to the shore, and vast beds of seagrasses are characteristic of the area. A thin veneer of quartz sand and organic debris overlies the limestone plateau of the Ocala-Middle Ground Arch. Occasional limestone outcrops protrude through this veneer to provide hard substrate. Species composition is predominatly the same found in estuarine seagrass or oyster reef communities. The shoreline receives only low energy waves.

(d) Cape San Blas Area: Moderate wave energy quartz sand beaches are characteristic of the area from Alligator Harbor, and comparably composed sediments extend some distance offshore. The fauna is similar to that of the Coastal Barrier Islands area in that it is predominantly a temperate sand community. Most common species are represented in both areas.

(2) Shallow Shelf (10-30m): This is the first major zone

of tropical species intrusion into the eastern Gulf. Rock substrate allows establishment of many scleractinian, alcyonarian, molluscan, crustacean and other invertebrate species common in shallower waters in the Florida Keys. Sand dwellers are represented by some species from more inshore waters but with many tropical species as well. Sediments are still largely of quartz sands, with increasing percentages of biogenically derived carbonates seaward. Overlying green, relatively turbid, coastal waters are usually well mixed, but cooler waters are often separated by a low thermocline, especially during warmer months.

(3) Middle Shelf I (30-60m): Two apparent physical characters separating this zone from the shallow shelf are widespread carbonate sediments and an overlying mass of blue, offshore water. The intersection of this water mass with coastal green water is usually very visible in depths of about 30m. Widespread rock outcrops are lower in the central and southern portions than on the Florida Middle Grounds, where they may rise 12 m above the surrounding bottom. Loggerhead sponges, corals and tropical algae form communities supporting many other tropical species. Appearance of many tropical sand dwellers is probably due to largely carbonate sediments. Communities are highly diverse,containing many more species than found in inshore zones.

(4) Middle Shelf II (60-140 m): Few rock outcrops are found in this zone. Sediments are almost entirely carbonate, being composed of coraline alga (Lithothamnion), bryozoan and molluscan

fragments; foraminiferal tests begin to contribute noticeably to sediments. Scattered sponges, bryozoans, ascidians and alcyonarians attached to small rocks and shells form the dominant sessile epifauna. Many small molluscan and crustacean species are very common. Bottom water temperatures seldom exceed 22°C, are warmest in late fall, and are usually distinctly separated from warmer surface waters except during winter when mixing may occur. This zone receives waters from the Florida Loop Current, and salinities greater than 36.5 $^{o}/oo$ occur seasonally. The fauna is essentially tropical or tropically derived; some data suggest a small number of endemic northeastern Gulf mollusks at these depths.

(5) Deep Shelf (140-200 m): It is problematical that a separation exists between 60 and 200 m. Sediments seem generally similar throughout; naturally water temperatures are depressed and little light penetration prevents most algal growth in deeper waters. Species diversity apparently decreases in these greater depths, but many species of the Middle Shelf II zone occur here. Changes in species composition noticeable at about 140 m in both fish and mollusks prompt designation of this depth as the intersection between zones. Pequegnat (1970) noted a number of brachyurans most common in depths corresponding to the deep shelf zone.

## Mississippi-Alabama Shelf

A major physical feature influencing community compositions here is proximity to the nearby DeSoto Canyon, with a resultant steeply sloping shelf and nearshore intrusion of oceanic waters to high

wave energy beaches. Mississippi Delta sediments are characteristic of the area from Mobile Bay westward.

As on the West Florida Shelf, far more collections have been taken than have been reported; most reports consist of individual species records rather than compendia of collections.

(1) Shoreward Zone: Quartz sand is the dominant sediment element to depths of approximately 20 m from Cape San Blas to near Mobile Bay. The fauna is characteristically temperate sand dwellers. Many species common here are uncommon to absent in other eastern Gulf sand communities. Moreover, many species found elsewhere in the eastern Gulf attain larger sizes in the zone west of Cape San Blas. Jetties and wrecks provide hard substrate for some tropical species which could not otherwise occur here. Muds become more important near the Mississippi Delta, with correspondent lowering of the number of species present.

(2) Deeper Areas: Faunal zone demarcations beyond the shoreward zone are not clear. Rocky outcrops first occur commonly off Panama City and Destin in about 20 m, but these diminish in number at comparable depths to the west. A highly diminished tropical fauna occurs on these outcrops. A zone of calcareous sediments occurs on deeper parts of the shelf, and even a few limestone reefs are known near the edge of the shelf. Species from these calcareous communities are essentially the same as from others further south, but diversity may be reduced.

As in shallower areas, these sediments merge into sands, muds and silts from the Mississippi outfall to the westward. Faunal change and species diversity reduction accompany this transition to soft bottom communities.

(3) Slopes: Calcareous sands give way to foraminiferal sands and muds in this area where the bottom slopes steeply (200-3200 m) from the shelf to the Gulf floor. Many species are confined to these depths, forming a characteristic slope fauna. Obviously, in so great a depth-span most are not found throughout, but many do exhibit considerable bathymetric range. Species diversity of many groups is markedly lower than for shelf zones, but penaeid and large caridean shrimps and galatheids show their greatest diversity here.

In summary, benthic invertebrates of the eastern Gulf are a highly diverse group with several dissimilar zones of distribution ranging from the shoreward zone to the continental slope. Whereas temperature and salinity fluctuations are limiting factors in estuaries, such values become more constant offshore. These narrow ranges of fluctuation are important for the dominantly tropical offshore fauna. Bottom substrates and overlying water masses seem to become more critical offshore. The northern limestone base, best expressed at the Middle Grounds, and the southern quartz sand extensions are contrasting features superimposed upon this basic scheme. However, differences are nowhere near as absolute as might be deduced from the previous geological charts. Scattered limestone communities occur as

frequently to the south as do scattered sand communities in the north. Where these communities are found, species compositions are essentially the same within zones.

Additional description and data on benthos for five discreet lease tract areas in the MAFLA (Mississippi-Alabama-Florida) shelf areas of the eastern Gulf of Mexico, extending from approximately 89°W, south of Pascagoula, Mississippi, to a tract west of Clearwater, off Tampa Bay, Florida may be found in Appendix E. This survey was conducted by the State University System of Florida Institute of Oceanography Consortium for the Bureau of Land Management prior to oil and gas operations for the MAFLA area as a result of Lease Sale No. 32.

## Texas and Louisiana Shelf

Parker (1960) conducted a detailed study of the benthic communities off the Texas and Louisiana coast. He divided the offshore communities into the following habitats: surf zone or sandy beaches; inner shelf, 4 to 23 meters; intermediate shelf, 24 to 65 meters; outer shelf, 69 to 120 meters; the upper continental slope, 125 to 1200 meters and the calcareous bank community and speciated organisms for each assemblage for characterization of each community.

In summary he found that variations occur within the major associations according to sediment type. Assemblages living within silty clays in the intermediate shelf community are completely different in composition from those on sand bottom at the same depth. Certain species do bridge the two sediment types to create larger associations. Studies of the continental shelf in other parts of the world and in all oceans proved the same basic assemlages listed for Louisiana and Texas occupy similar depths in the same latitudes (Parker, 1960).

3. <u>Nekton</u>

The continental shelf and estuarine environments of the northern Gulf of Mexico comprise a large portion of the Carolina Zoogeographic Region. Briggs (1973) described the Region for the Gulf as being that Region extending south to, or almost to, the tip of the Florida peninsula on the east and Cape Rojo near Tampico on the west. The Atlantic Coast section extends from Cape Hatteras to Cape Kennedy. Of the two, the northern Gulf is richer in species and demonstrates a fairly high degree of endemism (about 10 percent) in both invertebrates and fishes (Briggs, 1973). The latter has probably functioned as the primary evolutionary center and has contributed species to the Atlantic Coast section by means of a glacial stage migratory route around the tip of the Florida peninsula (Briggs, 1970).

The majority of biologists who have worked in the northern Gulf of Mexico have called attention to the presence of mainly warm-temperate or sub-tropic assemblages rather than tropical or Caribbean biota. The fauna is comparatively rich and includes many species that are found nowhere else, yet less is known about it than that of any other coastal section of the United States.

Knowledge on shelf and offshore fisheries for the western and central Gulf has been mainly limited to check lists, identification keys, and distributional studies. James, et al. (1972) stated that very little is known about the ecological relations of most fish species of the shelf, especially those which live beyond the inner

shelf. The inner shelf area is defined by Parker (1960) as that region between 4 to 23 meters water depth, intermediate 24-65m and outer 66 to 120m. Data presented by Hildebrand (1954) and Moore, et al. (1970) on fish faunas of the innter and intermediate shelf showed catches on the inner shelf to be less abundant and less diverse than those on the intermediate shelf. Hildebrand (1954) recorded only 80 fish species from the innter shelf whereas 122 species are recorded for the intermediate zone.

Data by James, et al. (1972) from fish collections on the continental shelf of Texas in 1971 suggested a greater species diversity for the inner shelf and greater abundance on the outer shelf, with the intermediate shelf being intermediate in fish diversity and abundance (Table 4), or a greater abundance is found closer to shore and the species diversity increases as one moves into deeper waters. Catches on the inner shelf are seasonally quite variable and tend to be dominated by species which utilize the estuarine habitat in part of their life histories.

Table 4 Comparison of Trawl Fish Catches in Relation to Shelf Zone for the Upper and Central Texas Continental Shelf*

| Shelf Zone | Diversity (No. of spp.) | Abundance (No./Haul) | Dominant Groups | Dominant Species |
|---|---|---|---|---|
| Inner shelf (4-23m) | 61 | 161.9 | searobins (26%)<br>flatfishes (21%)<br>drums (20%) | blackfin searobin (*Prionotus rubio*)<br>spotted seatrout (Cynoscion nebulosus)<br>Atlantic threadfin (*Polydactylus octonemus*) |
| Intermediate shelf (24-65m) | 48 | 245.1 | flatfishes (45%)<br>seabasses (20%)<br>searobins (10%) | shoal flounder (*Syacium gunteri*)<br>spotted whiff (*Citharichthys macrops*)<br>blackear seabass (*Serranus atrobranchus*) |
| Outer shelf (66-120m) | 23 | 312.7 | searobins (49%)<br>lizardfishes (31%) | shortwing searobin (*Prionotus stearnsi*)<br>largescale lizardfish (*Sauridia brasiliensis*)<br>blackear seabass (*Serranus atrobranchus*) |

* By R. M. Darnell (Id. by C. Cashman). Most of the collections were made during the period May-July, 1971. Source: James, et al. (1972).

A summary of the fish fauna for the northern and eastern Gulf of Mexico has been summarized by Briggs (1973). His report provides a detailed, concise treatment for this subject and is presented in part below:

The fish fauna of Cedar Key, Florida was studied by Reid (1954) who found that the assemblage consisted mainly of warm-temperate species and was similar in composition to that found along the Texas coast. Later additions to our knowledge of the fishes of Cedar Key by Caldwell (1954, 1955, 1957) and Berry (1958a, 1958b) considerably extended Reid's list but still indicated strong warm-temperate relationships. The fishes of Alligator Harbor on Apalachee Bay, Florida, have been reported on by Joseph and Yerger (1956) and by Yerger (1961). This also, is primarily a warm-termperate rather than a tropic fauna.

Farther to the south, an ecological study of the fishes of the Tampa Bay area by Springer and Woodburn (1960), together with local collections Briggs (1973), have shown that the fauna is basically warm-temperate. An ichthyological survey conducted at Charlotte Harbor near Fort Myers by Wang and Raney (1971) yielded about the same result. From Charlotte Harbor southward along the Gulf coast the distribution of the fishes is very poorly known. Somewhere in this area, perhaps at Cape Romano, there exists a major zoogeographic boundary.

There is no doubt that the fish fauna of the Florida Keys is tropical (Briggs, 1958; Starck, 1968). However, Tabb and Manning

(1961), who conducted an ecological survey of species were more common in the waters along the west coast of Florida and the northern Gulf of Mexico than they were in Biscayne Bay, only 50 miles to the east. This may mean that the boundary between the warm-temperate and tropical fauna should be located between Florida and Biscayne bays rather than at Cape Romano. Research needs to be devoted to this question.

Research currently being carried on in the vicinity of Sarasota by Gregory Smith (personal communication, 1975) indicated that the deeper, offshore waters of the shelf support a fauna that is quite different from that found inshore. The offshore community contains many tropical species while a number of the typical warm-temperate species are absent. The deeper waters, below about 20 meters, remain markedly warmer during the winter and this probably makes it possible for the offshore tropical species to maintain themselves far north of their usual habitats.

The presence, in the inshore waters of the northeastern Gulf of Mexico, of a geographically anomalous pocket of tropical fauna has been revealed (Caldwell and Briggs, 1957; Briggs, 1958; Caldwell, 1959, 1963). So far, 15 tropical species have been taken within the 60 mile stretch between Panama City and Destin. One species, *Acanthurus randalli*, is apparently endemic to the area but the rest appear to be identical with their relatives in the Florida Keys some 500 miles to the south. It is probable that the inshore establishment of such species is a seasonal occurrence but why should it take place in this particular area and not elsewhere on the Gulf coast of Florida?

In summary, except for the presence of low salinity water at the surface near the Mississippi Delta, the chemical and physical qualities of the shelf waters are similar on both sides of the northern Gulf of Mexico. However, when one looks at the distribution of the fauna, some interesting differences become apparent. The fish fauna of the northeastern Gulf is richer due mainly to the presence of a number of eurythermic tropical species. It has been suggested (Briggs, 1958) that this contrast in species diversity may be caused primarily by presence of different benthic communities.

The work of Hedgpeth (1954) on the bottom communities of the Gulf showed a virtually continuous association of coral patches and sponges covering the board continental shelf west of Florida from the Keys almost to the western boundary of the State. West of the latter, the coral-sponge association is abruptly replaced by the shrimp ground community. There are a few scattered coral reefs on the deeper parts of the shelf off the Texas coast but, so far, their fauna is not well known.

Baughman (1950) believed that the western Gulf had an entirely different faunal complex, cut off from Florida by the "vast and silt-laden flood on the Mississippi". Ginsburg (1952) indicated agreement with this view and, in addition, suggested that in some past geological epoch a peninsular barrier existed between Cape San Blas, Florida and Mobile Bay, Alabama. However, since tropical shore fishes in particular tend to become highly specialized and dependent upon certain types of bottom fauna for food and shelter, there seems to be

a sound ecological basis for the differences apparent in the fish faunas of the two sides of the northern Gulf and no need to look for a physical barrier.

In the northern Gulf, there is also some indication of speciation which certain warm-temperate genera. For example, one species of Menhaden, Brevoortia gunteri, is found in the western Gulf while another, B. smithi, exists in the eastern part (Dahlberg, 1970). Similar patterns have been found in the blenniid genus Chasmodes (Springer, 1959) and in the flatfish genus Gymnachirus (Dawson, 1964). In each of these cases, small area of geographical overlap has been found but these do not occur, for all three genera, in the same part of the northern Gulf.

Although many studies, Bright & Cashman (1974), Caldwell (1959, 1963). Causey (1969), Hubbs (1963, 1965), Moseley (1966), Smith (in press), Smith et al., (in press), Walls (1973) have been conducted concerning the fish fauna of offshore banks (hard substrates) of the northern Gulf of Mexico, only two studies have been directed towards studying the fish fauna of offshore oil platforms. Sonnier, et al (in press) made observations, photographs and collections of fishes on the western reefs of the outer Louisiana continental shelf and around oil platforms and verified the presence of an extensive tropical fish fauna. Of 105 species recorded, about 50% were tropical species either unreported or rarely reported from the northwestern Gulf of Mexico. Reefs contained more species than oil platforms, although a number were common to both (Table 5), and 12 species were found only around platforms (Table 6). The 67 species of fish found at the deeper reefs were all typical

Caribbean - West Indian species. No estimates concerning biomass between the two sides of the Gulf of Mexico has been reported.

Sonnier et al. (in press) found that platforms generally show a lesser growth of epifauna than the reefs studied, suggesting fewer niches, so their estimate of species occurring on platforms (49) and on the reefs (93) probably reflects realities about the greater numbers of species occurring on the reefs. Also the platforms studied were inshore of the deeper reefs and subject to lower temperatures possibly reducing the number of species of platforms.

Hastings et al. (in press) studies the fish fauna associated with two U. S. Navy research platforms in the northeastern Gulf of Mexico off Panama City, Florida at irregular intervals from 1970 to 1974. They found that major species occupying the platform habitats were fishes usually characteristic of pelagic, inshore (coastal or estuarine), and rocky reef environments.

For additional description of nektonic communities for the northern Gulf of Mexico see the following graphics:

(1) Pelagic and industrial fisheries - general Gulf, Graphic 4, Vol. 3.

(2) Migration of Gulf of Mexico penaeid shrimp and main fishing grounds - general Gulf, Graphic 4, Vol. 3.

(3) Coastal Zone and offshore fisheries - western, central and eastern Gulf, Graphic 5, Vol. 3.

(4) Undersea features - western, central and eastern Gulf, Graphic 4, Vol. 3.

Table 5 Species Occurring Both at Platforms and Reef Areas Sampled

| Species | Reef Area A | Reef Area B | Reef Area C | Platforms |
|---|---|---|---|---|
| *Dasyatis americana*-Southern Stingray | C [1/] | C | C | R |
| *Epinephelus adscensionis* - Rock hind | C | C | C | O |
| *E. itajara* - Jewfish | R | | | C |
| *Mycteroperca phenax* - Scamp | C | C | C | C |
| *Apogon maculatus* - Flamefish | C | C | C | O |
| *Rachycentron canadum* - Cobia | O | | | C |
| *Caranx hippos* - Crevalle jack | C | C | C | C |
| *C. latus* - Horse-eye jack | C | C | C | C |
| *Elagatis bipinnulata* - Rainbow runner | | O | C | R |
| *Selene vomer* - Lookdown | C | O | | C |
| *Seriola dumerili* - Greater amberjack | C | C | C | C |
| *Lutjanus campechanus* - Redsnapper | C | C | | C |
| *L. cyanopterus* - Cubera snapper | R | | | R |
| *L. griseus* - Gray snapper | C | O | | C |
| *Rhomboplites aurorubens* - Vermilion snapper | O | C | C | O |
| *Haemulon aurolineatum* - Tomtate | C | | | O |

1/ C = Common
O = Occasional
R = Rare
(Source: Sonnier et al.,in press)

Table 5 (Continued)

| Species | Reef Area A | Reef Area B | Reef Area C | Platforms |
|---|---|---|---|---|
| *Archosargus probatocephalus* - Sheepshead | R | | | C |
| *Equetus umbrosus* - Cubbyu | R | | | R |
| *Kyphosus sectatrix* - Bermuda chub | C | C | | C |
| *Chaetodon ocellatus* - Spotfin butterfly fish | O | O | O | O |
| *Holacanthus bermudensis* - Blue angel fish | C | C | C | C |
| *H. ciliaris* - Queen angelfish | O | O | O | O |
| *H. tricolor* - Rock beauty | | O | O | R |
| *Pomacanthus paru* - French angelfish | C | C | C | C |
| *Pomacentrus variabilis* - Cocoa damselfish | C | C | C | C |
| *Amblycirrhitus pinos* - Redspotted harkfish | | O | O | R |
| *Bodianus pulchellus* - Spotfin hogfish | | | O | O |
| *B. rufus* - Spanish hogfish | C | C | C | R |
| *Thalassoma bifasciatum* - Bluehead | C | C | C | O |
| *Sphyraena barracuda* - Great barracuda | C | C | C | C |
| *Scomberomorus cavalla* - King mackerel | C | | | C |
| *Aluterus scriptus* - Scrawled filefish | | | R | R |
| *Balistes capriscus* - Gray trigger fish | C | C | C | C |

Table 5 (Continued)

| Species | Reef Area A | Reef Area B | Reef Area C | Platforms |
|---|---|---|---|---|
| *B. vetula* - Queen triggerfish | | R | O | R |
| *Cantherines pullus* - Orange-spotted filefish | | R | | O |
| *Canthidermis sufflamen* - Ocean triggerfish | O | C | C | C |
| *Canthigaster rostrata* - Sharpnose puffer | O | O | O | O |
| Totals | 30 | 28 | 25 | 37 |

Table 6 Species Primarily Associated with Platforms

| Species | |
|---|---|
| Epinephelus nigritus - Warsaw grouper | C 1/ |
| Rypticus maculatus - Whitespotted soapfish | C |
| Caranx crysos - Blue runner | C |
| Chloroscombrus chrysurus - Atlantic bumper | R |
| Vomer setapinnis - Atlantic moonfish | R |
| Ocyurus chrysurus - Yellowtail snapper | O |
| Chaetodipterus faber - Atlantic spadefish | C |
| Pomacanthus arcuatus - Gray angelfish | R |
| Hypleurochilus geminatus - Crested blenny | C |
| Acanthurus coeruleus - Blue tang | R |
| Aluterus schoepfi - Orange filefish | R |
| Monacanthus hispidus - Planehead filefish | C |

1/ C = Common
O = Occasional
R = Rare
(Source: Sonnier et al., in press)

4. Marine Mammals, Birds and Sea Turtles

Several species of marine mammals, birds and sea turtles constitute the wildlife species of the open Gulf. However, due to the difficulty in obtaining data, information is rather scarce in most of the populations.

Woolfenden and Schreiber (1973) summarized data available on the pelagic birds in the Gulf of Mexico. Little is known about the birds of the Gulf of Mexico, however, the records that do exist suggest the Wilson Petrel is one of the few species of open Gulf waters that occurs regularly in fairly large numbers. The species is virtually never seen within sight of land, and little information is available regarding its food.

Four species of boobies are known to occur in the Gulf of Mexico; however, only one is common in the eastern Gulf, the Gannet. The Gannet breeds in the North Atlantic. The breeding ranges of the three species rare in the eastern Gulf, the Masked Booby *Sula dactylatra*, Red-footed Booby *S. sula* and Brown Booby *S. leucogaster*, though not well known, do not include the eastern Gulf of Mexico.

The Magnificent Frigatebird is a common summer resident along the Gulf coast of Florida north to Cedar Key. From here north and west along the panhandle the species occurs in small numbers. The bird roosts in mangroves, especially near breeding colonies of pelicans, cormorants, herons, and ibises, and takes surface fish and invertebrates from the open and coastal waters.

Jaegers are pelagic species rarely observed from land. All three

species occur in the Gulf of Mexico, but it is difficult to establish the relative numbers of each because all are similar in appearance and infrequently seen. Certainly the Long-tailed Jaeger *Stercorarius longicaudus* is rarest and the Pomarine Jaeger *S. pomarinus* may be less abundant than the Parasitic Jaeger (Williams, 1965).

Sooty Terns and Brown Noddies are true pelagic birds, and the Sooty may be the commonest bird in the Gulf of Mexico. Both these pelagic species disappear from the Tortugas area after their annual breeding (Dinsmore, 1972) and almost never are they seen along the mainland.

Records of Lowery (1960) indicated that oceanic birds in Louisiana waters included shearwaters, jaegers and petrels. It would be reasonable to expect these species to occur throughout the Gulf of Mexico.

During the winter season, hundred of thousands of waterfowl occupy virtually the entire length of the Gulf coast. Primary species utilizing the open Gulf include, scaups, redheads, canvasbacks, and scoters.

According to data from Raun and Gelback (1972) and the Florida Committee on Rare and Endangered Plants and Animals (unpublished data), five species of sea turtles occur in the Gulf waters in this assessment area. These include the leatherback, loggerhead, green, Atlantic ridley and hawksbill. The leatherback, hawksbill and Atlantic ridley are listed as endangered by the U. S. Department of the Interior (1974h). However, the hawksbill is a marginal species in the Gulf occurring only

as far north as Sanibel Island.

Their distribution can be considered Gulf-wide. The loggerhead is apparently the only species that nests on beaches in the Gulf of Mexico. Reports indicate the species may nest on the Chandeleur Islands off the Louisiana coast. The primary nesting sites are located on the beaches of the western and southern half of Florida in the Gulf. Sea turtle nesting areas are depicted in Graphic 4 Vol. III of the western, central and eastern Gulf visuals.

The primary problems confronting the turtles in the Gulf are disturbance of nesting sites and drowning in shrimp trawling nets. It is apparent that the general populations are in jeopardy and are probably decreasing.

Several species of marine mammals are recorded for the waters of the Gulf of Mexico (Table 6.1). However, most of these records are based on stranded individuals or fortuitous sightings and do not indicate population status.

Schmidly and Melcher (1974), Lowery (1974), and Caldwell and Caldwell (1973) have covered the available data for the Gulf. If appears that the spotted dolphin and bottle-nosed dolphin are the only marine mammals of any abundance in the Gulf of Mexico in this assessment area. The endangered manatee, however, is relatively common in Florida estuarine waters (Graphic 4, Vol. 3, Eastern Gulf).

Since 1965, several observations of California sea lions were reported by Lowery (1974) off the Alabama and Louisiana coast. However, it is doubtful if there is an established population in the area.

5. Biological Sensitive Areas

For purposes of discussion, reefal features adjacent to or contained in certain lease blocks for this proposed sale will be treated in the narrative below. Discussion on other reefal features may be found in preceding sections.

a. Flower Garden Banks; Texas

The following material is taken primarily from Bright, et al. (1974) with minor alterations. Although only the West Flower Garden bank was studied in detail, analogies can be drawn between it and the East Flower Garden bank.

The West and East Flower Garden banks are located south-southeast of Galveston, Texas on the outer edge of the continental shelf, see western Gulf, Graphic 4, Vol. 3. Both are capped by what are currently considered to be the nothernmost thriving tropical shallow water coral reefs in the Gulf of Mexico. The northern limit of Bahamian reefs is some twenty miles south of the Flower Gardens latitude. Reefs of the Bermuda Islands are nearly 300 miles north of the Flower Gardens latitude but they are situated 570 miles offshore from Cape Hatteras, North Carolina. The ecology of both the Bermudan and Bahamian island systems is influenced greatly by the warm Gulf Stream waters which surround them, and like the Flower Gardens, they harbor elements of the typical Caribbean reef fauna. The major hermatypic (reef building) corals of Bermuda (*Porites asteoides*, *Montastrea annularis*, *Montastrea cavernosa* and *Diploria* spp.) are the same as those found at the Flower Gardens (Moore, 1969).

Table 6.1 MARINE MAMMALS OF THE GULF OF MEXICO

| Common Name | Scientific Name |
|---|---|
| Block Right Whale | Balena glacialis |
| Humpback Whale | Megaptera novaengliae |
| Minke Whale | Balaeoptera acutorostrata |
| Bryde Whale | B. edeni |
| Fin Whale | B. physalus |
| False Killer Whale | Pseudorca crassidena |
| Killer Whale | Orcinus orca |
| Short-finned Pilot Whale | Globicephala macrorhyncha |
| Sperm Whale | Physeter catodon |
| Pygmy Sperm Whale | Kogia breviceps |
| Dwarf Sperm Whale | K. simus |
| Antillean Beaked Whale | Mesoplodon europaeus |
| Goose-beaked Whale | Ziphius cavirostris |
| Rough-toothed Dolphin | Steno bredanensis |
| Risso's Dolphin | Grampus griseus |
| Common Dolphin | Delphinus delphis |
| Bottlenose Dolphin | Tursiops truncatus |
| Long-snouted Dolphin | Stenella longirostris |
| Bridled Dolphin | S. frontalis |
| Euphrosyne Dolphin | S. caeruleoalba |
| Spotted Dolphin | S. plagiodon |
| Manatee West Indian (Florida) | Trichechus manatus |
| California Sea Lion | Zolophus californianus |

Bermuda, however, exhibits a profuse population of alcyonarian corals (sea-rods and sea-fans) which are missing from the West Flower Garden above 160 feet.

Within the Gulf of Mexico, the Flower Gardens appear to be elements of a discontinuous arc of reefal sturctures occupying the Gulf's southern and western continental shelf. The closest known well-developed coral reef is Blanquilla, off Cabo Rojo, about 60 miles south of Tampico, Mexico (Villalobos, 1971). Moore (1958) listed from these forty-three species of various invertebrate taxa typical of Caribbean reefs, many of them common to the West Flower Garden list.

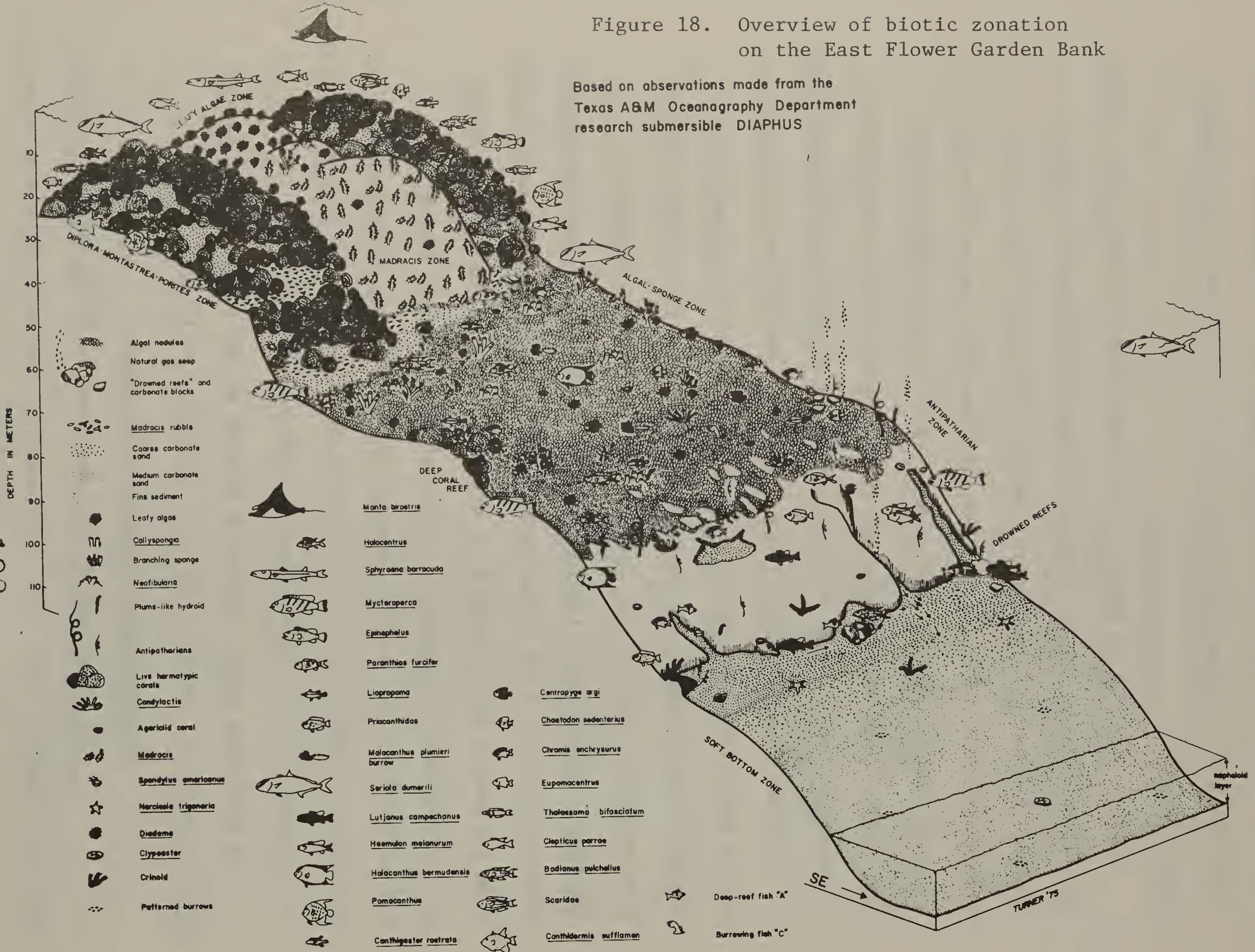
Benthic organisms inhabiting the West Flower Garden bank down to 450 feet depth are stratified into distinct biotic zones, the limits of which seem to be related to substratum type, light penetration and depth. The living reef, 70 to 160 feet, is a typical Diploria - Montastrea - Porites coral reef community. An Algal-Sponge Zone occupies the hard bottom between 140 and 270 feet and is separated from the deeper soft bottom by a narrow transition zone characterized by the presence of crinoids. Scattered over the Soft Bottom Zone, 250 to 450 feet, are ancient drowned reefs harboring a unique deep reef biota. Figures 18 and 18.1 represent an overview of biotic zonation on the East and West Flower Garden banks respectively.

The following tracts contain a portion of one of the Flower Banks: Tract 25 (E.F.G.), Tract 26 (E.F.G.) and Tract 29 (W.F.G.)

b. Fishing banks; Louisiana and Texas

The first bank to be considered is 28 Fathom Bank, see Western Gulf, Graphic 4, Vol. 3. This bank has a rather complicated topography

Figure 18. Overview of biotic zonation on the East Flower Garden Bank



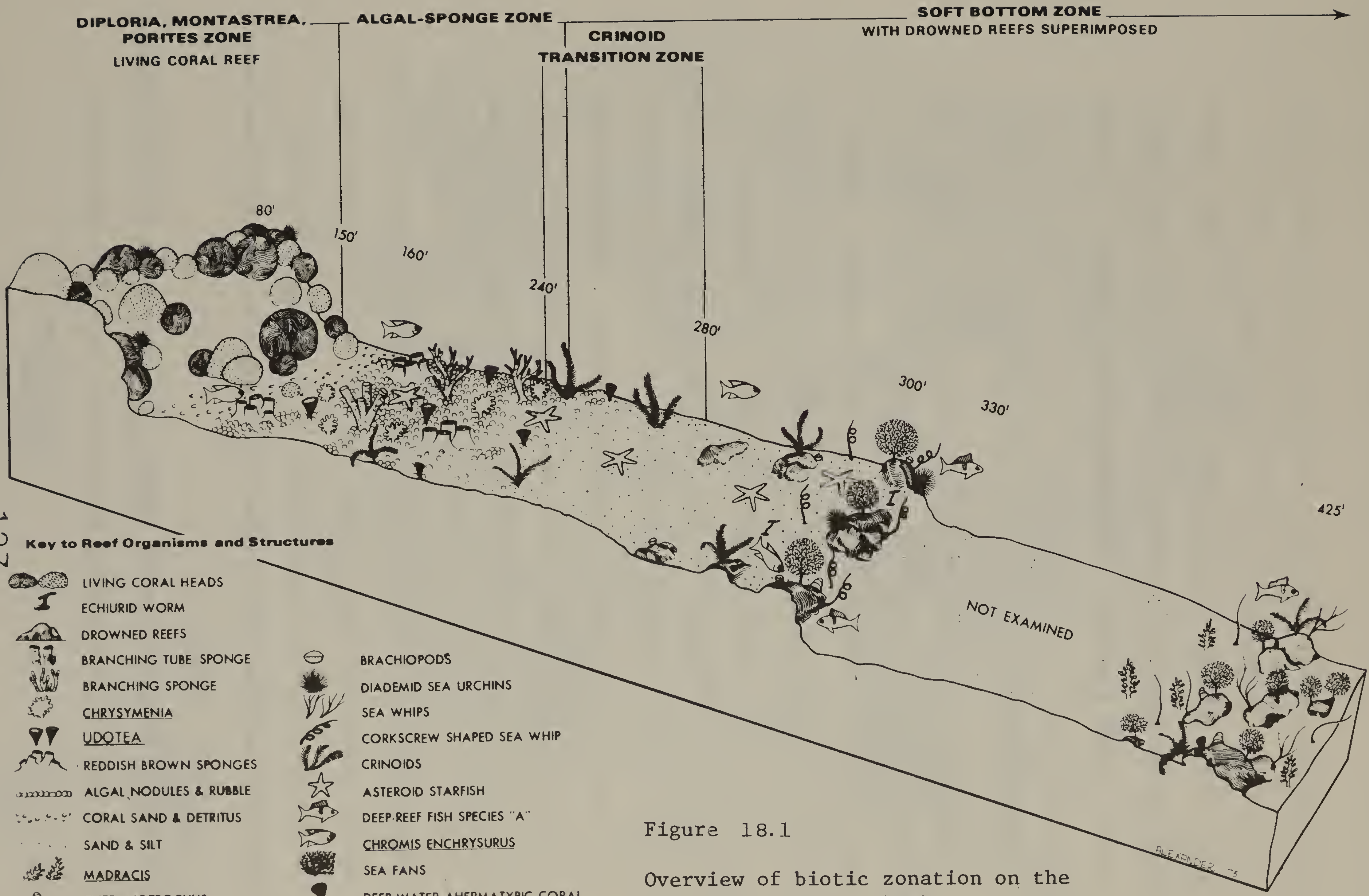


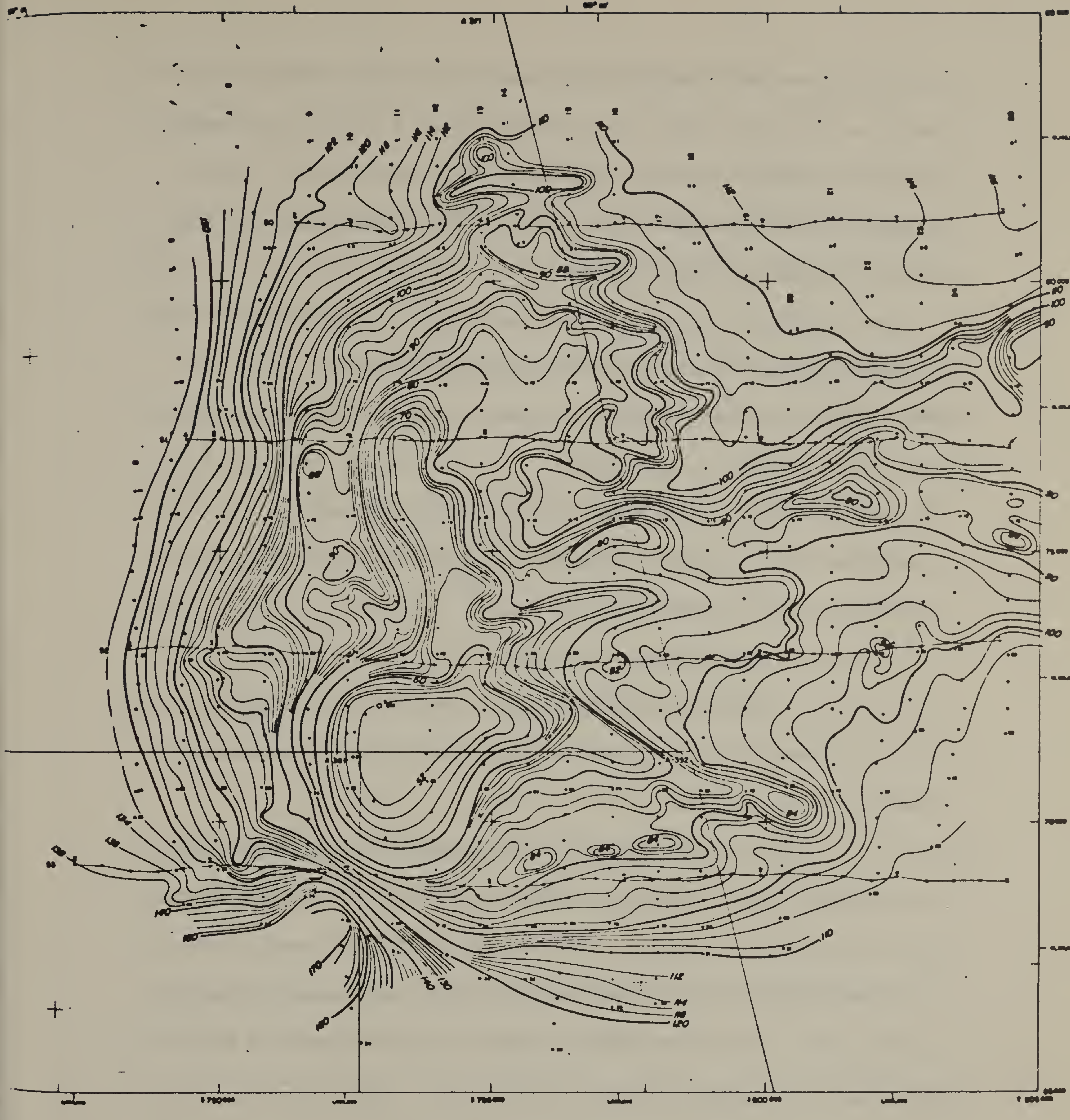

Figure 18.1

Overview of biotic zonation on the West Flower Garden bank.

with many small peaks (Fig.19). The slope on the southeast side is very steep, dropping fast from 60 to 170 meters. Directly south of this bank the bottom becomes shallower and likely another bank is located there. In general, this bank has a north-south trending center from which ridges and channels radiate in various directions.

Tract 30 contains a portion of 28 Fathom Bank. Other banks located in or adjacent to lease tracts in this proposed sale are not as well known as those previously discussed. The principle banks of concern for this discussion are those located offshore western Louisiana, see Central Gulf, Graphic 4, Vol. 3. Sonnier, et al. (in press) stated that a number of rocky prominences are located offshore of Louisiana from the edge of the continental shelf inshore to within approximately 92 km of the coastline. These rock structures are occasionally very abrupt, located in depths ranging as great as 125-155m with narrow pinnacles jutting to within 30m of the water's surface. The origin of all of these pinnacles has not been proven, but it is generally conceded that they are caused by subsurface salt domes or other diapiric structures and associated faulting (Uchupi and Emery, 1968), and salt has been demonstrated from those at the shelf edge (Lehner, 1969). Parker and Curray (1956) have reported some invertebrates collected in dredges but most groups remain unstudied.

Largely because of their absence from current navigational charts and the lack of any intensive survey of the area, numerous similar



HIGH ISLAND AREA
GULF OF MEXICO - TEXAS
**28 FATHOM BANK**

FEET

Figure 19

CONTOUR INTERVAL 2 METERS
DATUM: SEA LEVEL
SOUNDINGS IN METERS
⊙ BENCH MARK

TEXAS LAMBERT GRID
SCALE 1"=1000'

structures have gone unstudied and remain virtually unknown. Such formations exist all along the Louisiana coast but they occur with greatest frequency between 92 and 94°W. longitude in water depths ranging from 24-185m. The extent of the bottom expression varies greatly (Parker and Curray, 1956).

Juhl (personal communications) and Carpenter (1965) identified the above mentioned banks as productive snapper lumps. Carpenter (1965) stated that these areas have been a major source of snapper in the Gulf of Mexico since 1892.

The following tracts contain or may contain a portion of a fishing bank in either offshore Louisiana or Texas. They are tracts 7, 35,37,47,53,56,63 and 72.

c. Fishing Banks; Florida

The following descriptions of banks for offshore Florida were taken from Moe (1970), and Futch, Futch and Smith (personal communications).

(1) Tracts 77,78,79 and 80 are located in a fishing area from 29°27' to 29°41'N and 85°49' to 85°59'W. The water depth varies from 17 to 25 fathoms. The bottom is primarily sand with occasional patches of shell and mud with rock ledges associated with the mud areas. These rock ledges have a relief of three to five fathoms and are heavily covered with growths. There are also a few wrecks in the area that produce very well when located.

(2) Tract 88 has been identified as being located in a snapper-grouper fishing bank area. Water depth for the area is 17 to

20 fathoms. Relief is unknown; however rocky ledges do exist in the area.

(3) Tract 92 is located in an area of high relief. Coordinates are 28°23'N and 83°22'W. Rock ledges and formations extend up to 14 feet above a sand and shell bottom. Water depths are from 15 to 70 feet.

(4) Tracts 95 and 96 are located in a flat area of sand and shell with many low limestone reef formations. Water depths range from 50 to 60 feet.

(5) Tracts 102,104,105,106,107 and 113 are located in fishing area from 27°42' and 27°53'N and 83°16 to 83°28'W. Water depths are 54 to 100 feet. The southern section of this area has a rolling sand and shell bottom with scattered rock and sponges; the northern section has a flat sand and shell bottom with rocky areas of moderate relief. Numerous ledges and crevices are present.

(6) Tracts 113 and 114 are located in an area with a well defined ridge of limestone rock about 3 miles across at its widest point and varying from 4 to 8 fathoms in height. Range of water depths is 25 to 34 fathoms.

All of the above fishing areas and banks for Florida may be found on the eastern Gulf, Graphic 4, Volume 3.

## F. Biological Environment of the Coastal Zone

The length and biological diversity of the coast of the eastern Gulf of Mexico (Florida) exceed those of any of the other Gulf states. Tidal swamps and marshes fringe the entire coast and submerged vegetation blankets most of the shallow-water bottom. This diversity supplies habitat for numerous species of wildlife (many of them endemic) as well as some sub-tropical birds.

The paramount feature of the central Gulf coast is the Mississippi River delta and its associated seven million or more acres of marsh and estuaries. The Mississippi watershed covers about one-third of the United States, and the resultant freshwater discharge is responsible for the major saltwater dilutions within the central Gulf coast region. The estuaries of Louisiana, the most extensive in the Gulf, supports the third largest shrimp production and the second largest oyster production in the United States (U. S. Dept. of Commerce, 1975).

East of the Mississippi Delta, the proportion of estuaries to the coastal zone diminishes and becomes more commonly characterized by high energy sand beaches. The wetlands which are present are extremely valuable in terms of biological productivity.

Along the northwest Gulf coast, the marshlands diminish rapidly into a narrow band along the coast, and are nearly absent in the semiarid regions of south Texas. A significant portion of the coastal zone, however, is composed of a vast system of bays and lagoons which are engendered for the most part by the extensive system of

barrier islands.

The direct distance along the arc of the Texas coastline between its political boundaries is roughly 370 miles. The extent of mainland shoreline, however, as described along its many dendritic bays, is approximately 1800 miles. Eight major bay systems penetrate the Texas coast, and all except the Sabine River estuary are fronted by a portion of a 300 mile chain of barrier islands and peninsulas. The uniqueness of this coastal barrier is two-fold: It is the longest barrier island system in the world and is comparable in magnitude to the Great Barrier Reef off western Australia; and less than a dozen inlets and passes provide the narrow arteries for exchange between the embayed waters and the open sea.

The seaward margin of the Texas coast, comprised mostly of barrier islands, is a nearly continuous strand of sand beaches. Shoreward of the beaches is the man-made Intracoastal Canal which courses the entire length of the coast. The area of coastal marsh is roughly 622 square miles, but is limited to a narrow band along the coast with its greatest extent at the Sabine area and then diminishes southward.

The interested reader is referred to Final Environmental Statements No. 38, FES 75-37 (pp. 44-50) and No. 37, FES 74-63 (pp.131-174) prepared by the Bureau of Land Management for a more detailed description of the coastal environment for the central and western Gulf.

The following discussion will treat only the environment of the eastern Gulf.

1. Salt Marsh

Salt marsh habitat of Florida has been mapped by Davis (1967) and is indicated in eastern Gulf, Graphic 4, Vol. 3. As can be seen, the most extensive areas of salt marsh occur from Tarpon Springs to the Port St. Joe area.

According to Humm (1973), vegetation consists primarily of three grass species, one rush and several species of forbs.

Salt marsh grass (Spartina alterniflora) comprises the most seaward of the vegetation zones where it endures the deepest and longest inundation by salt water. Black rush (Juncus roemerianus) inhabits the next zone inland and therefore occurs on slightly higher ground. This species forms almost pure stands to heights of six to seven feet and functions to slow down tidal penetration. The third zone inland is dominated by salt grasses (Distichlis spicata and Spartina patens). This zone is rarely inundated except during high tides.

Salt marshes support considerable populations of rails, sparrows, ducks, numerous shorebirds and a few reptiles. The area also functions as a hatchery for fish and invertebrates which are essential to the maintenance of the higher vertebrates.

For additional information on the salt marshes of this geographic area, the reader is referenced to Final Environmental Statement, Vol. 1, Sale 32, FES 73-60, pp. 144-149, Final Environmental Statement, Vol. 1, Sale 37, FES 74-63, pp. 131-175 and Final Environmental Statement Vol. 1, Sale 38, FES 75-37 p. 45.

2. Mangrove Swamp

Mangroves in this assessment area are for the most part restricted to Florida. However, small mangrove communities do exist on some of the barrier islands, particularly the barrier islands of Louisiana.

Three species of mangrove trees, red mangrove (Rhizophora mangle), black mangrove (Avicennia germinans), and white mangrove (Laguncularia racemosa) occur in this region; buttonwood (Conocarpus erecta), although not a true mangrove, is important in the transition zone between the swamp and upland vegetation. (Davis, 1940).

The different species of mangrove trees sometimes grow in randomly mixed associations, but usually different species dominate certain bands or zones which are clearly delimited from the others. This characteristic zonation pattern results from differences in rooting and growth of seedlings and from various competitive advantages which each species has in the several gradients present from below the low water to above the high water lines.

Red mangrove seedlings sprout in marl soil below the low tide level; these form the most seaward band. This species may be easily recognized by its arching prop roots and by the long slender seeds which germinate before dropping from the tree. The prop roots are the most important attachment surfaces for sessile organisms in the intertidal region. On slightly higher intertidal peat soil is the red mangrove zone; the prop roots of these trees are inundated by almost every high tide. The zone inland is composed of black mangrove trees growing on flat areas flooded by the higher tides. Black

mangrove has characteristic pneumatophores. Large numbers of these slender appendages grow up from the main roots until they emerge from the mud. Still further inland buttonwood swamps and blackrush marshes form the transition band between the mangroves and either the tropical forest trees or the sawgrass (*Mariscus jamaicensis*), plants that are unable to survive significant amounts of salt. White mangrove is found in all zones but usually not as the dominant; it is often most abundant near the brackish marshes between the black mangrove and buttonwood zones.

The mangrove trees themselves are certainly the dominant producers in the swamps, but algae also are important, especially because their production may be much more quickly consumed by the mangrove fauna than the woody materials produced by the trees. In Florida, open shoal areas below mean low water are often covered by tropical species such as *Caulerpa*, *Acetabularia*, *Penicillus*, *Gracilaria*, *Halimeda*, *Sargassum*, and *Batophora* (Davis, 1940 and Taylor, 1954). Above this region, on the intertidal muds one may find a thick growth of *Vaucheria* or *Cladophoropsis* (Taylor, 1954). There is also a subterranean algal flora composed of unicellular and filamentous blue-green and green algae (Marath, 1965). The prop roots of the red mangrove have several zones of algae attached to them. In Puerto Rico, the permanently submerged portions of the roots often have rich growths of *Acanthophora*, *Spyridia*, *Hypnea*, *Laurencia*, *Wrangelia*, *Valonia* and *Caulerpa*; the intertidal zone may be covered by species of *Murrayella*, *Centroceras*, *Polysiphonia*, *Enteromorpha*, and *Rhizoclonium*; finally, there may be species of *Catenella*, *Caloglossa*, and *Bostrychia*

at the upper limit of high tide (Almodovar and Biebl, 1962).

Many kinds of animals are found in mangrove swamps, in sharp contrast to the low diversity of plant species. The most important benthic marine animals are probably crustaceans and mollusks and most of these can be classified as either deposit or filter feeders. Fiddler crabs (*Uca* spp.) in Puerto Rico frequently are dominant in terms of biomass (Golley, et al., 1962). The crabs on intertidal flats of mangrove islands in Florida bay include *Uca pugilator*, *U. speciosa*, *U. thayeri* and *Eurytium limosum*; other species, *Aratus pisonii*, *Sesarma curacaoense*, and *S. reticulatum* are abundant in mangroves above high water (Tabb, et al., 1962). Barnacles such as *Balanus eburneus* attach to roots and stems where they can filter their food from the water at high tide. Coon oysters (*Ostrea frons*), also important filter feeders, are abundant on mangrove roots in Florida and the weight of their shells may eventually cause the root to break off. The dead shells and undigested food of these barnacles and oysters contribute to the sediments of the swamp. Several kinds of snails (*Cerithium*, *Melogena*, *Cypraea*, and *Littorina angulifera*) feed on material deposited on the roots or on the mud surface (Davis, 1940; Tabb et al., 1962). Some vertebrates of the Florida swamps include turtles, crocodiles, alligators, bears, wildcats, puma, and rats (Davis, 1940).
Other important consumers in Florida swamps are amphipods, isopods, the crab *Rhithropanopeus harrissii*, and fishes, especially *Cyprinodon variegatus*, *Mcllinesia latipinna*, and *Floridichthys carpio*.

Birds are abundant, conspicuous, and probably important in mangrove

swamps. Approximately half of the species utilize the swamp for nesting activities and the others feed there or congregate there in large communal roosts. The food resources of the birds are varied. Many (egrets, herons, ibis, ducks, kingfishers, crab hawks, stilts, and pelicans), feed on estuarine fishes and invertebrates, others (fly-catchers, woodpeckers, wrens, swallows, and warblers) feed on insects in the forest, and a few (doves and blackbirds) feed on seeds outside the swamps but return for roosting or nesting. The mangroves themselves and their fruits, however, do not supply nutriment directly and the food supply for birds, like that of the other animals, comes predominantly from marine life in the channels or on the mud flats. The dense nesting colonies in some areas may harm the trees physically, but the excreta probably is of some benefit.

Florida mangrove swamps also serve as nursery grounds for many animals species of economic importance--menhaden, black mullet, spotted sea trout, snook, tarpon, red drum, mangrove snapper, pompano, and pink shrimp. Edible oysters growing on the bottoms of shallow bays or on the mangrove prop roots are also harvested in some places.

3. Estuaries and Embayments

Lyons and Collard (1974) reported on the estuarine habitat for the eastern Gulf of Mexico. Their data provide a detailed, concise treatment of this environment and is presented in part below:

The single category "estuary" contains much of the first four of Collard and D'Asaro (1973), i.e., "low salinity communities;" "oyster reef communities;" "oyster, mangrove and hard substrate communities;" and "bays, channels and sounds". The authors also recognized various subdivisions within most categories, based on salinity, temperature, vegetation and substrate.

It is sufficient here to state that these areas, located along most of the eastern Gulf coast, are characterized by salinity gradients generally ranging from 0 to ca. 34 $^{o}/oo$, with broad fluctuations caused by rainfall (or lack thereof), tides and other factors. Temperature fluctuations are usually much greater than in other marine environments. Substrates may vary considerably, both within a single estuary and between estuaries. Nutrient values are generally higher than in other marine environments.

Of these factors, perhaps temperature and salinity fluctuation and high nutrient values are most characteristic in separating estuaries from other marine communities. However, substrate and vegetation are just as important in determining composition of communities. All factors are, to some degree, interrelated.

A remarkably high number of benthic invertebrates are adapted

to exist under the rigorous conditions of east Gulf estuaries. Cooley (No Date) has listed more than 500 species in the Pensacola Bay area, Menzel (1971) has noted at least that many estuarine species in the Alligator Harbor area, and certainly more than 600 species occur in the Tampa Bay estuarine system (Taylor, 1971; Hall and Lyons (ND); other unpublished data). Much of the Florida West Coast may be considered "ecotonal" between the temperate Carolinian and tropical Caribbean zoogeographic provinces. Such areas, generally high in species diversity, result from occurrence of hardier types from each province. Constituents of both provinces occur throughout the area, although naturally more species of temperate affinity are found in the north and more of tropical origin occur in the south. There is also a small Gulf endemic element. However, most estuarine species are not easily assignable to any of these categories. Instead, as noted by Lyons et al. (1971), they belong to a broadly ranging, eurytolerant group found at least from North Carolina to the southern Caribbean. Broadly fluctuating salinites and, to an extent, temperatures, are characteristic of habitats through much of their range. They are basic elements of most estuaries, while the "provincials" and endemics, more sensitive species, serve to characterize individual estuarine differences. These subtleties result in "northern" and "southern" communities.

a. Low salinity communities (marshes and deltas; marshes and mangrove swamps)

Each of these is characterized by low salinity and

organically rich sediments. Mangrove communities are dominant in the south but entirely absent in the north, primarily due to low temperature intolerance. *Spartina*-*Juncus* marshes occur extensively in the north, but much less so in the far south. Both occur south of Cedar Key, but with mangroves increasingly dominant to the south.

b. Oyster reef-hard substrate communities

This is the major sessile invertebrate community of eastern Gulf estuaries. It is based upon *Crassostrea virginica* throughout the region, but widely diverse temperatures and salinities dictate different species associations at different localities.

c. Bays, channels and sounds

Though still characterized by broadly fluctuating salinities and temperatures, overall mean values may be higher than in the previously mentioned areas. These factors are still important in determining local species composition, but substrate, vegetation and depth are also major factors.

Substrates may vary from muds, terrigenous sands and mixtures thereof in the north to vegetable debris and calcareous sands in the far south. Terrigenous sands are not important south of Cape Romano. Quartz sandshell mixtures dominate most of west Florida, but muds become important west of the Apalachee Bay area.

Pure or mixed stands of seagrasses occur in estuaries throughout the region. Species include *Thalassia*, *Syringodium*, *Halodule* and *Ruppia*. Two species of *Halophila* are less common. Most of these

grasses reach their greatest densities in estuaries, but in this area are generally limited to depths less than two meters because of poor light penetration. This leaves greater estuarine depths as non-vegetated substrate inhabited by species not tied to a "grassbed" existence.

Aside from oyster reefs and grassbeds for epiphytes, most estuarine substrate may be characterized as "soft". Because "hard" substrate is rare to nonexistent in the Carolinian Province, there are few "hard" substrate Carolinian species. It seems, therefore, that except for certain grassbed or oyster reef species, eastern Gulf estuaries have been surrendered to "soft bottom" Carolinian species by default. Exceptions may occur where introduced objects such as pilings or jetties provide setting space for Caribbean species, but even these objects are usually occupied by species from oyster reef or grass communities.

Generally, estuaries are herein considered as coastal invaginations, often separated from the Gulf of Mexico by barrier islands. However, certain shallow offshore areas of low wave energy display typical estuarine characteristics. These include extensive shorelines from Apalachee Bay to the Anclote Keys and, further south, the Ten Thousand Islands area from Cape Romano to Cape Sable. These seem to represent estuaries intergrading directly into shallow shelf communities.

The value of the estuarine environment to wildlife species is

obvious when various papers are reviewed. Without a doubt, avifauna far outnumber any other species in utilization of the estuarine habitat. Sprunt (1967), Lynch (1967) and Palmisano (1972) all discuss use and importance of this habitat to various species of birds. Woolfenden and Schreiber (1973) identified 81 species of birds whose existence in the eastern Gulf depended primarily on the saline environment. Most of these species were closely associated with the estuaries.

4. Seagrasses

Humm (1974) provides the most recent data on seagrasses of the eastern Gulf. The following narrative is presented verbatim as this best describes the situation as it applies to this proposed sale area.

> "The inner part of the great continental shelf along the Florida Gulf coast supports the most extensive seagrass beds of the continent of North America. A major stand of these seagrasses occurs from Tarpon Springs northward to Port St. Joe of the Florida panhandle in sub-region C of Earle (1969), an area in which the seagrass beds are essentially continuous for a distance of about 250 miles. The gentle slope of the inner shelf in this area is such that these seagrass beds are more than ten miles wide in many places, extending from the intertidal zone out to depths of six to eight meters or more" (Humm 1973).

Three species (perhaps four, if den Hartog, 1970 is followed)

make up about 99 percent of the biomass of these seagrass beds: _Thalassia testudinum_ (Konig and Sims), _Syringodium filiforme_ Kutzing in Hohenacker, and _Halodule wrightii_ Ascherson (_Diplanthera wrightii_ [Ascherson] Ascherson). The relative abundance of these four species is presumed to be in the order given above, based upon general observations of the beds and of the quantity of leaves washed ashore. Quantitative data are available from only a few small areas (Zimmerman, Feigl, Ballantine and Humm; Ballantine and Humm; _In_: Baird et al., 1972) and are not adequate for interpolation to include large areas.

A fourth species, _Halophila engelmanii_ Ascherson in Neymayer, occurs in the beds mixed with _Thalassia_, presumably in relatively small quantity. Here again, the presumption may be erroneous as no quantitative data are available. A fifth species, _Halophila baillonis_, is known only from deeper water north of Tampa Bay and apparently does not occur in the beds. It forms, presumably, small patches at depths of eight to thirty meters but apparently no one has studied it in the Gulf of Mexico.

A sixth species, _Ruppia maritima_ L., is present off river mouths, especially in beds of _Halodule wrightii_, but also mixed with _Thalassia_. It is not a true seagrass as its normal habitat is fresh water; however, it extends into the sea in places as it can tolerate considerable salinity.

The seagrass beds between Tarpon Springs and Port St. Joe are probably the most important community of the inner shelf in basic productivity. Apparently they far exceed the basic productivity of

phytoplankton in the area they occupy, perhaps several thousand square miles of inner shelf bottom. Their ecological importance, however, is not only their basic productivity; they also provide what may be an essential environment for many species of invertebrates and fishes, including some of economic value in both sport and commercial fisheries.

Humm (1973) also noted that seagrasses exhibited significant environmental functions in the eastern Gulf:

(a) They serve as a sediment trap and a stabilizer of bottom sediments from the waters edge to a depth of six to sixteen meters or more.

(b) They carry on basic productivity that in the eastern Gulf, may considerably exceed that of benthic algae or phytoplankton in the same area.

(c) They serve as a direct food source (fresh) for a few animals, including sea urchins, sea turtles, manatees, certain herbivorous fishes; partially decomposed leaves in the form of detritus serve as a food for a wide variety of detritus-feeders, especially invertebrates but also some fishes.

(d) They serve as a place of refuge, as a source of food organisms as well, for juveniles of many species of seafood organisms including shrimp, crabs, bay scallops and fishes.

(e) They provide a habitat for a certain assemblage of invertebrate species that burrow or grow attached to the

leaves; organisms that may be uncommon or absent from habitats that lack seagrasses.

(f) They provide an important substrate for attachment of scores of species and a significant biomass of benthic algae that otherwise would be rare or absent in an area.

5. Barrier Islands

Barrier islands off the coast of Florida are found from Cape Sable to Anclote Key and from Lighthouse Point to the Florida-Alabama state line. The beaches in this reach consist of fine white sand composed of white quartz and bleached shell fragments. Along the Gulf coast the continental shelf is considerably wider than on the Atlantic coast. The wider shelf results in flatter beach slopes.

Detailed information is not available on the vegetation of the various islands. However, a perspective of the general vegetative complexes has been provided by Davis (1967). Generally, the islands of the Florida coastline consists primarily of coastal strand vegetation which is composed of various species of forbs, dune-grasses and shrubs. Trees and shrubs dominate in the inland areas of larger islands. On the better drained soils on some of the islands, stands of sand pine occur on the inland dune areas.

Wildlife use is comparable to that of other barrier islands in the Gulf and is dominated by shore and wading birds and small mammalian species. The islands of Florida also provide the primary habitat for nesting rookeries of the loggerhead turtle in the Gulf though the extent

of use is unknown.

Many of the islands also provide essential habitat for shore and wading bird rookeries.

Collard and D'Asaro (1973) reported on the faunal components of high energy beaches. Organisms inhabiting these areas are adapted to survive the scouring force of wave action by burrowing into the sand. The beach flea, Emerita and the bivalve, Donax are able to bury themselves almost instantaneously which enables them to survive in the surf zone.

Away from the surf-swept sandy beaches a trough generally occurs where benthic animals are partially protected from wave action during normal tidal and wave action. In this area representative species include the common whelks, Busycon; olive shells, Oliva; sand dollars, Mellita and certain starfish, Astropecten. At the seaward edge of shallow troughs where sand bars are located, Donax-Emerita communities are prevalent. Seaward of this area as the water deepens, large cockles, Dinocardium; sand dollar, Encope; sea pansy, Renilla and the common starfish, Luidia are found. A crossection of high energy beach communities can be seen in Fig. 20 .

6. Upland

Davis (1967) listed numerous vegetative types as representing the upland area of Florida. However, only five major types can be considered to be in close proximity to the coastal zone in this proposed sale area.

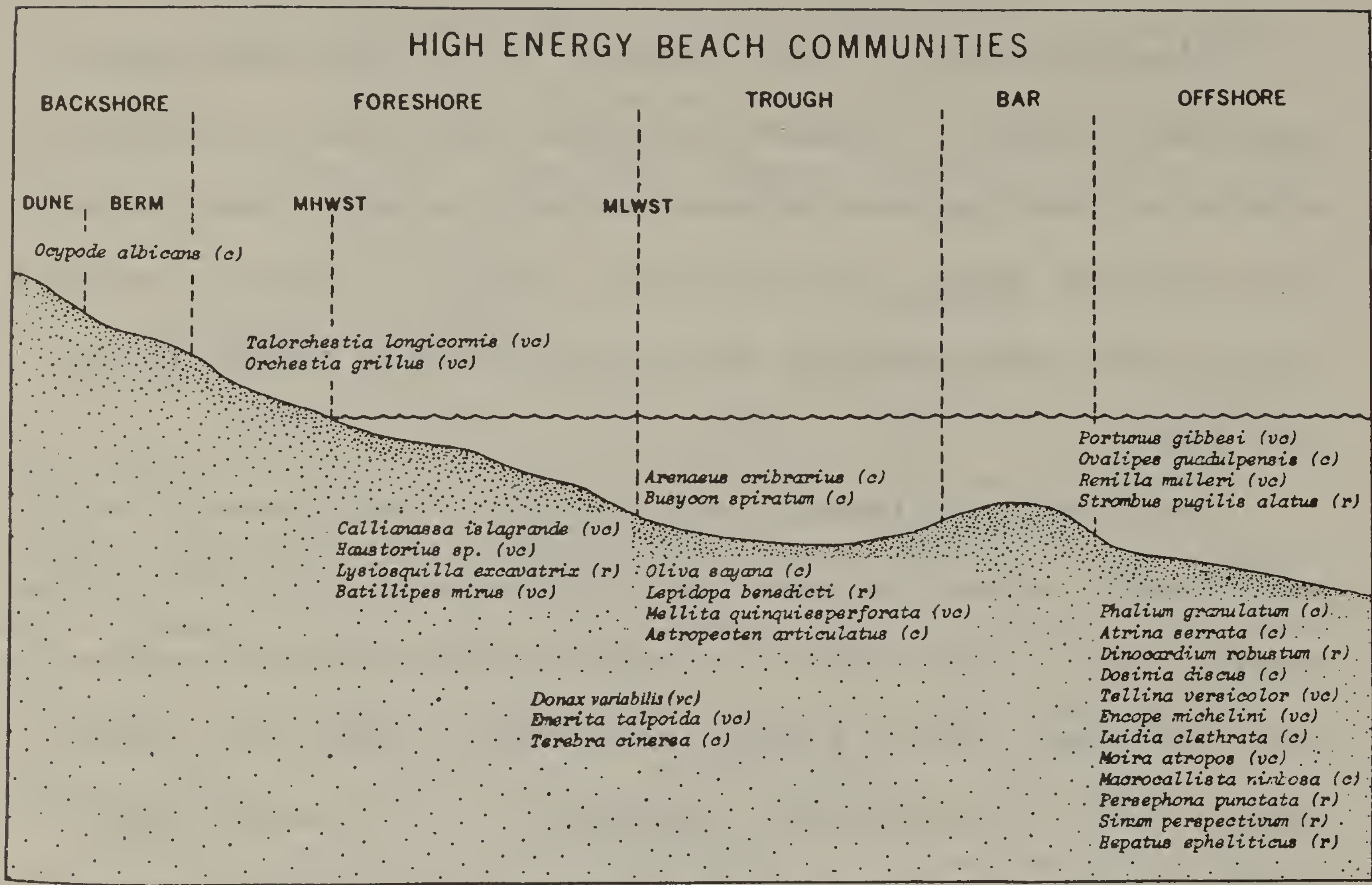



Figure 20. High Energy Beach Communities. Composition of these communities is essentially the same from the Mississippi barrier islands to Cape Sable. (Figure based on Dexter, 1969; Hedgpeth, 1954; Parker, 1956; Pearse et al., 1942)

(a ) Pine flatwoods

This complex consists of from one to three species of pine (longleaf, slash and pond). Herbs, saw palmetto, shrubs and small trees form the understory. Also intermixed in these areas are small hardwood forest, cypress swamps, prairies, marshes and bay tree swamps.

(b ) Hardwood forests

The species comprising this type include mixed evergreen and deciduous hardwoods. This type is found on rich soil uplands.

(c ) Longleaf pine

This type consists of longleaf pine and xerophytic oaks on well drained uplands.

(d ) Swamp forests

The species in this type is predominately hardwoods which include baytrees, gum, titi and cypress. This complex borders most rivers and occurs in basins.

(e ) Mixed hardwoods and pines

The mature forest of this type consists mainly of hardwoods but the younger forests are of mixed composition. This type is found in the clay soils of the northwest section of the state and is the most removed from the Gulf environment.

Summarized data on distribution and habitats of the various species of wildlife occuring in the upland environment as may be affected by this proposed sale are not available. However, Layne (1974) has summarized data on the land mammals of south Florida. It is reasonable to expect that much of the description of the species in this area is

applicable to other areas in Florida in comparable habitat types.

A unique characteristic of the Apalachicola area becomes apparent when the geographical range of several animals are reviewed. Animals such as various species of bats, the eastern chipmunk, red spotted newt, northern dusky salamander and the queen snake are found in the Apalachicola corridor. The existence of these animals along the Apalachicola River represents the only area in the deep south where these species are found.

Other information concerning selected species of the uplands and coastal zone are depicted in eastern Gulf, Graphic 4, Vol. 3.

## G. Human Utilization

### 1. Land Use

The interface of land and sea has created dynamic and diverse environments in the coastal zone. These natural features have been subjected to a variety of pressures in response to historic and continuing population and industrial expansion. These natural features act as both opportunities and constraints to development, resulting in a highly complex pattern of land, water and submerged land use and ownership.

Land use information is available for portions of the coastal zones of the five states bordering the Gulf of Mexico, but at varying scales, specificities, interpretations and stages of completion. For some regions, detailed land information is available, but formats are often inconsistent with adjacent regions. For the purpose of this discussion therefore, only references which allow a generalized, and consistent overview of the entire coastal zone were used.

#### a. Texas

The most comprehensive and current land use and ownership mapping, statistical inventories and descriptions for coastal Texas can be found in the partially completed series, Environmental Geologic Atlas of the Texas Coastal Zone (Fisher et al. 1973) which delineates the coastal line into seven reaches. Since mapping has been published for only three of the reaches, this information was not utilized.

The State of Texas owns submerged lands off the Texas coast seaward out to a distance of three marine leagues, or 10.35 statute miles, and landward to the point of mean high tide for the enclosed bay areas, and to the point of mean high or higher tide for the Gulf of Mexico beaches. This legal delineation is the dividing line between state and private ownership along most of the Texas coastline, as the area landward of this line is generally in private ownership.

The privately owned Gulf beaches shoreward of these state submerged lands and islands are subject to public use as a result of the Texas Open Beaches Act. This Act generally declares that the public has the right to gain access to, and to use and enjoy the beaches bordering on the Gulf of Mexico. More specifically, the Act guarantees the public "free and unrestricted right of ingress and egress to and from the state-owned beaches bordering on the seaward shore of the Gulf of Mexico, or such larger area extending from the line of mean low tide to the line of vegetation bordering on the Gulf of Mexico, in the event the public has acquired a right of use or easement to or over such area" (Section 1 of the Act). However, where there is no clear line of vegetation, the line "shall in no event extend inland further than two hundred (200) feet from the seaward line of mean low tide" (Section 3a of the Act).

The function of this Act is to make available for public access and use, all Gulf beaches with the exception of those on St. Joseph and Matagorda Islands, as they are not yet served by public right

of use or easement. Should public roads or ferries serve these areas in the future, these islands and their beaches would then come under the provisions of the Act. A proposed constitutional provision would extend this Act to these areas, even though such access did not exist.

Land use in the Texas coastal zone is highly variable both within and between regions, and this requires its portrayal in general categories at gross scales. More detailed categorical discussions can be found elsewhere under appropriate headings.

In the upper reaches, land use pressures are generally more intense because of the major population and industrial centers in that region, as described in the Environmental Geological Atlas of the Texas Coastal Zone - Beaumont - Port Arthur Area (Fisher et al., 1973).

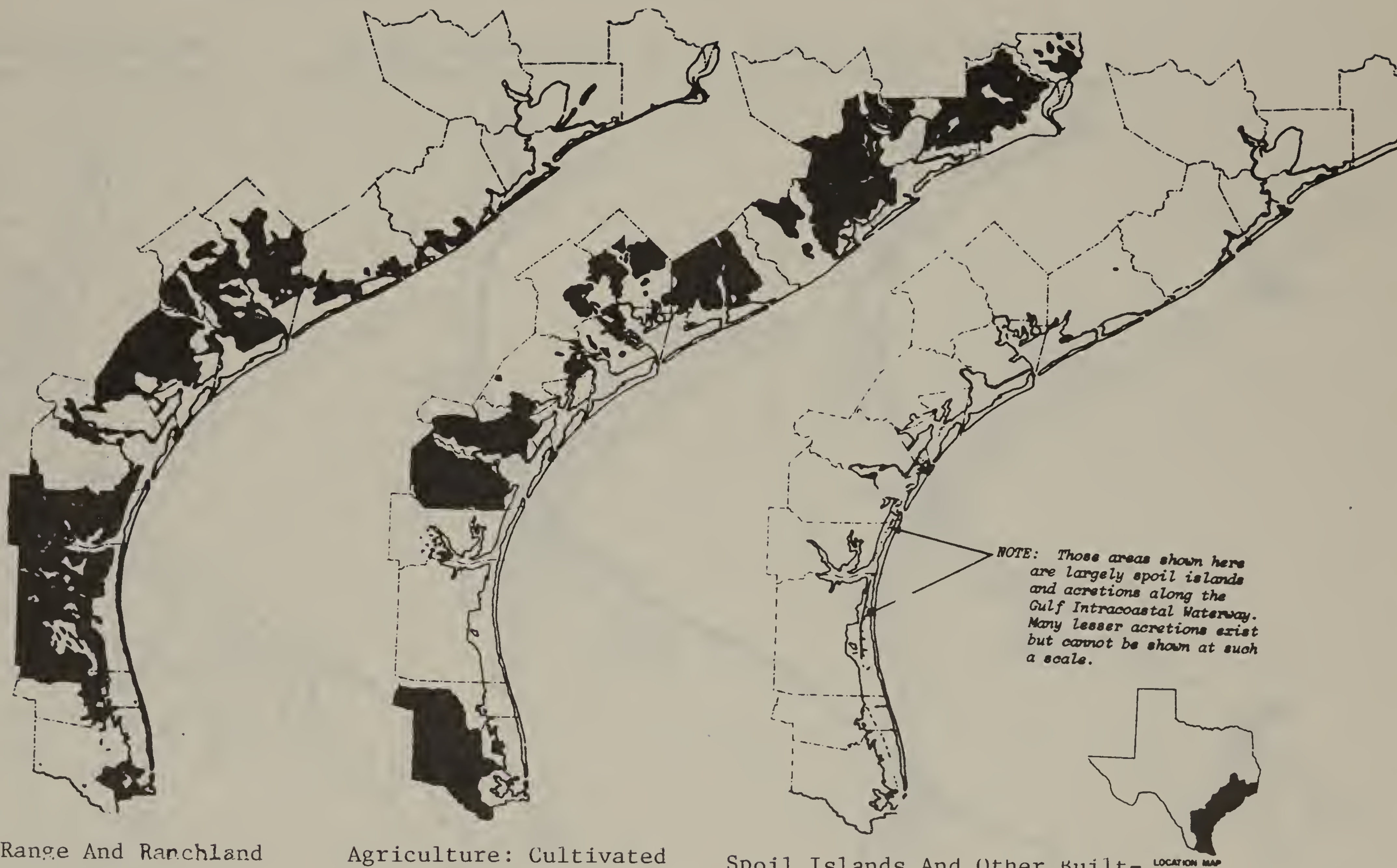
A number of factors in the upper Texas coastal zone contribute to diversified and extensive land and water use, especially in the Houston, Galveston, Beaumont, Port Arthur and Orange areas. It is an area amply endowed with mineral resources that supports one of the major petroleum refining and petrochemical centers of the world. It is an area with fertile and productive agricultural lands and finally, it contains major port facilities with extensive intra-coastal waterways and ship channels that have led to a high-volume flow of imports and exports.

Many of the factors have led to diverse land and water use in the Beaumont-Port Arthur area have also led to current and potential limitations and conflicts. Many of the resources of the area have varied uses, both present and potential. For example, water bodies are used simultaneously for transportation, commercial and sport fishing, recreation, oil and gas well locations, pipeline routes, as an area to fill for real estate development and as a part of a waste disposal system.

Certain of these uses are obviously in conflict. The area is undergoing rapid and dramatic physical change involving active shoreline processes, hurricane flooding and damage, subsidence and surface faulting. These changes interface with a variety of land and water uses.

In the lower reaches of the Texas coastal zone, many of the specific land uses are similar, but the acreage proportions differ from the upper reaches. Urban and industrial stress is less intense, and with the exception of the developed areas near Brownsville, Harlingen and Corpus Christi land use is generally more extensive, with large acreages devoted to agriculture, rangeland and ranching.

Patterns of land use and intensity can be found in a report, Land Use Patterns in the Texas Coastal Zone, (Flawn and Fisher 1970). Highly generalized patterns of gross categories are shown in Figures 21, 22 & 23 and a statistical summary of these acreages is shown in Table 8. The following is a summary of the coastal counties.




Range And Ranchland In The Coastal Zone

Agriculture: Cultivated Lands In The Coastal Zone

Spoil Islands And Other Built-Up Lands In The Coastal Zone

Figure 21. LAND USE IN THE COASTAL ZONE

(Flawn and Fisher, 1970)

Timber and Woodland
In the Coastal Zone

Recreational Beaches
In The Coastal Zone

Barren Lands
In The Coastal Zone

Figure 22. LAND USE IN THE COASTAL ZONE

(Flawn and Fisher, 1970)


Swamplands In The Coastal Zone

Marshlands In The Coastal Zone

Formal Wildlife Refuges In The Coastal Zone

Figure 23. LAND USE IN THE COASTAL ZONE
(Flawn and Fisher, 1970)

Table 8. Statistical Summary of Land Use - Texas Coastal Counties (Flawn and Fisher, 1970)

| Use | Totals |
|---|---|
| Total area 1/ | 16128.0 |
| Total land area 2/ | 13818.0 - 86.0 |
| Total water area 2/ | 2310.0 - 14.0 |
| **Land Areas** | |
| Agriculture 3/ | 5117.0 - 37.0 |
| Range and ranch 3/ | 4425.0 - 32.0 |
| Woodland and timber 3/ | 1609.0 - 11.6 |
| Marsh and swamp 3/ | 762.7 - 5.5 |
| Urban industrial and residential 3/ | 969.7 - 7.0 |
| Recreational 3/ | 23.3 - 0.2 |
| Subaerial spoil 3/ | 84.7 - 0.6 |
| Made land 3/ | 33.8 - 0.2 |
| Wildlife refuge 3/ | 213.4 - 1.5 |
| Barren land 3/ | 579.4 - 4.2 |
| **Water Areas** | |
| Bays 2/ | 2075.3 - 12.9 |
| Artificial reservoirs 1/ | 64.7 |
| Natural fresh water bodies 1/ | 170.0 |
| **Other Features** | |
| Bay shoreline 4/ | 1419.3 |
| Open ocean shoreline 4/ | 373.1 |
| Total shoreline 4/ | 1792.4 |
| Drainage channels 4/ | 3120.0 |
| Transportation canals 4/ | 668.0 |
| Hurricane flood areas 2/ | 3208.0 - 23.3 |

1/ Measured in square miles.
2/ Measured in both square miles (left number) and % of total area (right number).
3/ Measured in both square miles (left number) and % of total land area (right number).
4/ Measured in linear miles.

Source: Flawn and Fisher, 1970)

A brief discussion of these principal land and water uses and their distribution within the 18 county coastal zone follows. A more comprehensive discussion can be found in the Final Environmental Impact Statement FES 74-63 written for OCS Sale No. 37.

Agriculture - Approximately 5120 square miles (41%) of the total land in the Texas coastal zone are presently under cultivation. Concentration is on the original prairie grasslands of the central and upper coastal zone. Agricultural use becomes less extensive in the south Texas coastal zone with the progressive decrease in rainfall.

Sixty percent of the total production of rice in Texas comes from the coastal zone. The main producing counties are north of the San Antonio River, and include Brazoria, Chambers, Harris, Jackson, Jefferson and Matagorda. Relatively high rainfall and extensive irrigation are main contributing factors.

The second most important agricultural crop produced in the coastal zone is grain sorghums, accounting for about 12% of the total state production. Principal yields are centered in the Corpus Christi area (Nueces and San Patricio counties) and in the southernmost part of the coastal zone (Willacy and Cameron counties).

Use of the coastal zone land in the production of cotton is significant only in the coastal bend (Calhoun, Nueces and San Patricio counties) and in the lower Rio Grande Valley (Willacy County).

Minor quantities of corn, hay, oats and wheat are produced, accounting for less than 3% of the total state production. Concentration of these crops is in the central coastal zone (Matagorda, Brazoria and Harris counties), and is co-extensive with the area of principal beef production in the coastal zone.

Range and ranchland: Approximately 42% (4,425) square miles of the total area of the coastal zone is devoted to range and ranch sites; marshlands used as range sites include an additional 760 square miles. Principal sites include the more arid region of south Texas, the low-lying coastal marshes, and the nonwooded barrier islands and levees of the central and upper coastal zone. The grazing of beef is the principal use of the range land and is most significant in Brazoria, Harris, Jackson, Matagorda and Victoria counties.

Woodland and timber: Woodlands occur throughout the coastal zone of Texas but are most extensive in Orange, Brazoria, Matagorda and Kennedy counties. Smaller areas of woodlands elsewhere in the coastal zone occur along streams, including low-swamp areas with water-tolerant vegetation, and on certain of the abandoned Pleistocene barrier island sands. Total woodland area in the coastal zone is approximately 1,600 square miles. Principal vegetation in the upper coastal zone woodlands includes pine and mixed hardwoods; in the central coastal zone, a variety of water-tolerant hardwoods; and in the southern coastal zone, oak.

Marshlands: Approximately 760 square miles of the Texas coastal zone is marshlands or wetlands. These include dominantly low-lying coastal lands, the back sides of barrier islands, and low areas at the terminus of major river valleys and associated bayhead deltas. Salt marshes, brackish marshes and fresh-water marshes are restricted to areas below four feet above mean sea level. Grasses of varying tolerance to fresh and salt water are the sole vegetation. Most of the marshlands are used as ranch and range sites for the grazing of beef cattle.

Urban industrial and residential: The principal urban and industrial concentration is in the upper part of the coastal zone. Highest concentrations are in Brazoria (Freeport area), Jefferson (Galveston area), Harris (Houston area) and Nueces (Corpus Christi area) counties. Nearly 1,000 square miles are included in this use category.

Recreation: The area designated as recreation is primarily the public beaches of the coastal zone. This amounts to a total area of about 23 square miles. Not included are a variety of public parks and other recreational areas, surface waters and the Padre Island National Seashore.

Formal wildlife refuges: (Source: Texas A & M University, 1972). Five major national wildlife refuges are designated in the Texas coastal zone, including: Anahuac Refuge (9,940 acres) in Chambers County; Brazoria (9,530) and San Bernard (14,920 acres) refuges in Brazoria County; Aransas Refuge (54,830 acres) in Calhoun, Aransas

and Refugio counties; and Laguna Atascosa Refuge (45,150 acres) in Cameron County. There is one state owned wildlife management area, the J. D. Murphee Wildlife Management Area (8,400 acres) in Chambers County.

Barren lands: Barren lands comprise nearly 580 square miles in the coastal zone. Principal distribution of these lands is in the semiarid southern part of the coastal zone from Kleberg County south, and includes extensive wind-tidal flats landward of Padre Island as well as some of the active dune fields on the south Texas sand sheet.

Made land and spoil: Made land, or land built up to higher levels by grading, represents about 34 square miles in the coastal zone. These occur principally in metropolitan areas along the coast. Some of the spoil areas have re-established vegetation; other areas are barren.

Water: The extensive bays of the coastal zone comprise the principal surface-water bodies, covering approximately 2,100 square miles and making up about 13% of the total surveyed area of the coastal zone. Principal bays and estuaries include Sabine Lake; Trinity-Galveston Bay, including East and West Bays; Matagorda Bay, including East Matagorda Bay; Espiritu Santo Bay; Lavaca Bay; San Antonio Bay; Aransas Bay; Copano Bay; Corpus Christi Bay; Baffin Bay; and Laguna Madre.

Fresh-water bodies existing either as natural water bodies or as artificial reservoirs comprise the other water areas of the coastal zone. The surface are of natural water bodies in the coastal zone is about 1,700 square miles; artificial reservoirs cover about 65 square miles.

Hurricane flood: Approximately 3,208 square miles of the lower parts of the Texas coastal zone have been inundated by salt water from surges of hurricanes Carla and Beulah during the past decade. Particularly prone to flooding are the low coastal marshes and the lower reaches of the main river vallyes.

Shoreline: Total shoreline in the Texas coastal zone amounts to slightly over 1,890 miles. Of this total, 1,419 miles are bay shoreline and 373 are open-ocean or gulf shoreline. The shoreline is a dynamic zone subject to constant change in the form of erosion or accretion and is thus subject to change in total length.

Canals: An extensive canal system has been developed in the Texas coastal zone, including transportation, irrigation and drainage canals. Major transportation canals total 668 miles within the surveyed part of the coastal zone. Approximately 3,120 miles of irrigation and drainage canals have been cut in the coastal zone, mostly associated with agricultural lands.

Specific to the immediate shoreline is a land use study (Texas A & M University, 1972), which divided the coast into beach segments (Fig. 24) for the purpose of describing shoreline use. Each section of the coast is three miles in length along the beach, and extends from the ocean beach back to the approximate limit of hurricane high water, which was assumed to be 12 feet elevation. The following description of the physical and land use characteristics along the Texas coastal shoreline was abstracted verbatim from this study.

Shoreline segments 1-40: Padre Island, a barrier island between the Gulf of Mexico and Laguna Madre, extends south along the lower Texas coast for about 113 miles, ranging in width from a few hundred yards to about three miles. Padre Island has wide, clean, sandy beaches backed by sand dunes up to 40 feet high. Grass flats, smaller dunes, and mud flats make up the area between the primary dunes and Laguna Madre.

The long mainland shore of Laguna Madre, extending south about 117 miles from Encinal Peninsula to Port Isabel, is essentially undeveloped privately owned land. The King Ranch occupies a substantial part of the shore along this reach. The area adjacent to the shore is largely unpopulated and has experienced less change during the past century than any other section of the Texas coast. Baffin Bay, about 30 miles south of Encinal Peninsula, has some private residences and recreational facilities along its west bank. Port Mansfield is a sport and commercial fishing center, with harbor facilities for fishing vessels and small craft. The community has a

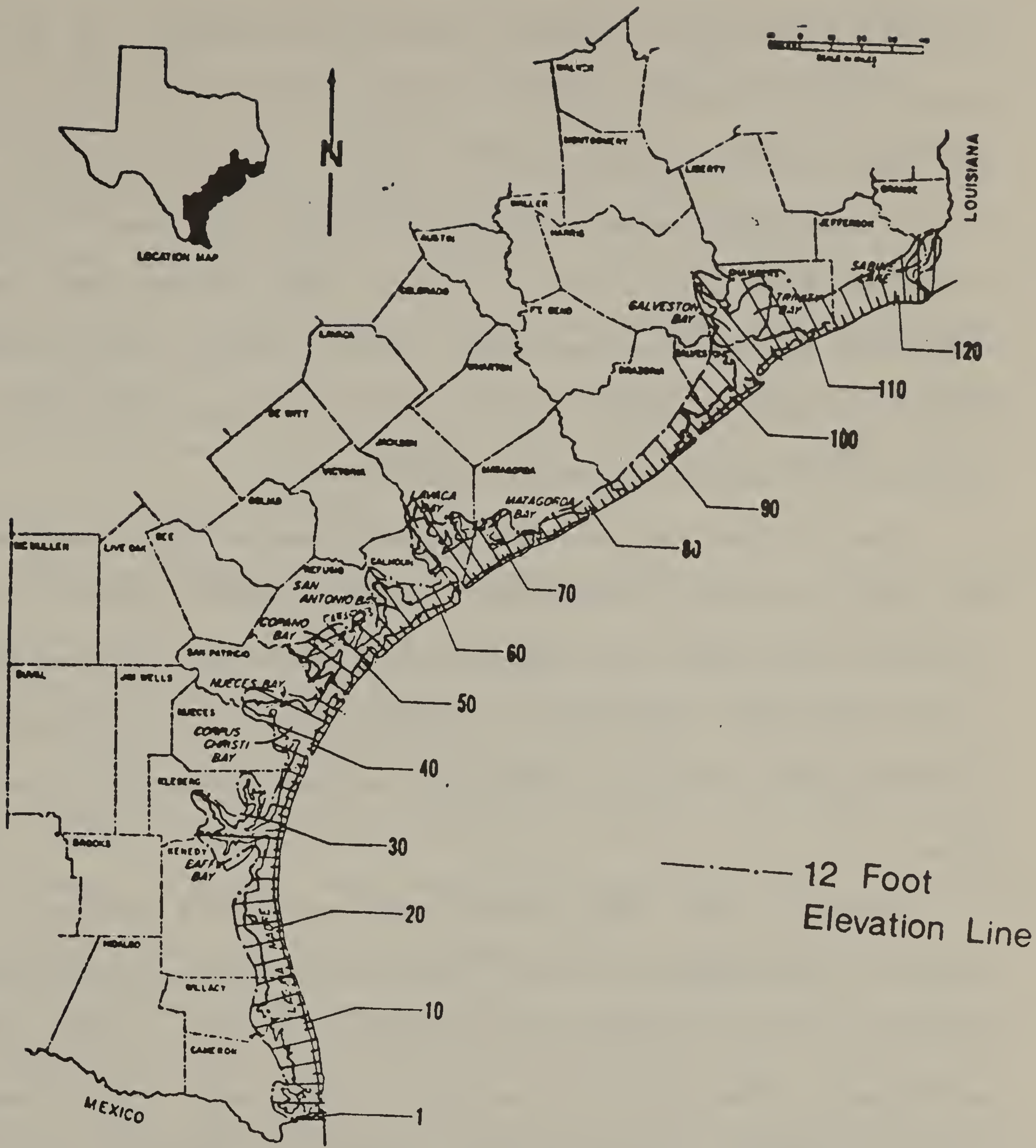



Figure 24. THREE - MILE ENVIRONMENTAL INVENTORY SHORELINE SEGMENTS (from Texas A & M University, 1972)

small number of permanent residents operating camps, motels and businesses catering to tourists, hunters and fishermen. To the south, Laguna Atascosa National Wildlife Refuge borders a large portion of the Laguna Madre shore between the mouth of the Arroyo Colorado and a point about eight miles north of Port Isabel. Between the wildlife refuge and Port Isabel, much of the area along the shore has been subdivided for permanent and summer homes. The Port Isabel waterfront is lined with hotels, docks, piers, boat launching ramps and seafood handling and processing establishments.

Brazos Island and the South Bay area between Port Isabel and the Rio Grande are mostly undeveloped. The Gulf shore of Brazos Island, including a two mile strip dedicated as a state park, is used for public recreation. Some private housing and a few tourist service establishments are located along this southern extremity of the Texas coast.

Except for some public recreational and private residential and commercial developments at its northern and southern extremities, there are no other significant developments on Padre Island. The development at the north end includes a county park, fishing piers, several concession type businesses catering to bathers and beach users, an elaborate hotel complex and a subdivision for permanent and summer homes. A concrete seawall about 12 feet high protects the hotel. On the south end of Padre Island, along a length of about five miles, apartments, beach homes, motels, parks, restaurants and other tourist accomodations have been constructed.

The federal navigation channel from the Gulf of Mexico to Port Mansfield extends through Padre Island about 38 miles north of Port Isabel. Most of the island north of the Port Mansfield Channel is occupied by the Padre Island National Seashore, a part 80.5 miles long dedicated to preserving that portion of the island in its natural state for the public's enjoyment. Padre Island National Seashore receives approximately 875,000 recreational visits each year (U.S. Department of the Interior, 1974i). Presently, there are camping and picnicking areas, an observation tower and a tourist center with additional facilities planned.

Shoreline segments 41-51: The major portion of St. Joseph Island is used for ranching and private recreation. A small portion of the southern tip of the island, adjacent to the Aransas Pass Navigation Channel, is owned by the Federal Government. Mustang Island extends from the Aransas Pass Navigation Channel to Corpus Christi Pass, a distance of about 16 miles. The 16-mile long beach front is a very popular recreational center for the south Texas region. Sand dunes up to 25 feet in height lie behind the beach front, except for a small number of areas where dunes have been breached by hurricane tides. The island provides a rather high degree of protection against hurricane tides and waves for the island areas around Corpus Christi Bay. The island has numberous beach homes and water oriented recreational type facilities. Port Aransas, located on the northern end of the island, is the only town on Mustang Island.

A causeway and ferry provide access to the northern end of the island, while the John F. Kennedy Causeway provides access to the south end. The north shore of Mesquite Bay and the east shore of Blackjack Peninsula are low and are part of the Aransas National Wildlife Refuge. The west bank of St. Charles Bay is undeveloped. The perimeter of Copano Bay has scattered developments of permanent type homes, fishing and hunting camps, farm buildings, and oil fields and supporting facilities. Most of the northwest shores of Aransas and Redfish Bays are well developed with permanent and summer homes. The cities of Rockport and Aransas Pass have many business catering to tourists, hunters,fisherman and other water oriented recreationists. Much of the bay shore at Fulton and Ingleside is partially protected from erosion by several different types of privately constructed revetments. Oil fields and permanent and summer residences occupy the northeast shore of Corpus Christi Bay. The northwest shore of the bay, including the town of Portland, has several residential subdivisions on bluffs, which range up to 30 feet above sea level. Oil and gas wells, piers and docks constitute the major development on the north shore of Nueces Bay. At the head of the bay, the shoreline is formed by the low, marshy delta lands at the mouth of the Nueces River. Much of the shore of Nueces Bay is undeveloped and is used as a spoil area for dredging operations in the Corpus Christi Ship Channel.

Corpus Christi, the largest city on the Texas coast, fronts the west and south shores of Corpus Christi Bay about 16 miles of highly developed and densely populated urban areas. Corpus Christi is an

important seaport and industrial center for petroleum and agricultural products and is also a major tourist and convention center. Most of the 16-mile reach of shoreline is protected from erosion by breakwaters, seawalls, bulkheads, groins and riprap.

A large part of the Oso Bay shoreline is a tidal flat and not developed to any great extent. The University of Corpus Christi occupies an island connected to the mainland by a causeway at the shore of Laguna Madre. Part of the Corpus Christi Naval Air Station, the residential and tourist community of Flour Bluff and a number of small slips and wharves serving sport and commercial fishing interests and service facilities for nearby oil and gas fields are located along the Encinal Peninsula shore. Many boating supply,bait, and fishing tackle businesses and launching ramps are located along the John F. Kennedy Causeway which connects the mainland with the north end of Padre Island and the south end of Mustang Island.

Shoreline segments 52-61: Matagorda Island is a remote area accessible only by boat or aircraft. About 60 percent of the 30-mile long island is occupied by the Matagorda Island Air Force Base and Gunnery Range. The southwestern end of the island is devoted to ranching. Recreation on the island is limited to private interests and military personnel because of the limited accessibility and restricted areas. The shoreline of Espiritu Santo, San Antonio, Guadalupe and Hynes bays are, for the most part, undeveloped. South of the town of Seadrift, the land is quite low and unsuitable for permanent type

structures. A low, concrete bulkhead protects about 3,700 feet of Seadrift's residential bay shore from wave erosion associated with strong south and southwest winds and minor tropical disturbances. Most of the upper part of San Antonio Bay is bordered by the low, marshy delta lands at the mouth of the Guadalupe River. Steep secondary banks up to 25 feet high rise about the river delta behind the normal shoreline. The west shore of San Antonio Bay is relatively high but undeveloped, except for the town of Austwell and a few scattered residences. The Aransas National Wildlife Refuge occupies the shore of San Antonio Bay from Webb Point to False Live Oak Point.

Shoreline segments 62-73: Matagorda Peninsula has the only Gulf shore in this zone. The peninsula, accessible only by boat or aircraft, is used primarily for ranching and recreation. Overnight camping is quite popular in the area of good fishing near the Matagorda jetties. Two private airstrips are located on the peninsula. Most of the perimeter of Matagorda Bay is sparsely populated marshland devoted to grazing except for the town of Port O'Connor and other small communities on the western shore. The western shore generally has sand and shell beach areas which are used considerably for recreation where public access is available. The bay shore of Port O'Connor is protected from normal wave action by a concrete bulkhead about 4,200 feet long. Near Well Point, on the north shore of Matagorda Bay, about 1,200 feet of the shore is occupied by the Texas Parks and Wildlife Marine

Biology Laboratory. Farm and ranch lands border a large portion of Tres Palacios Bay Shoreline. The bay shore of the town of Palacios is partially protected by a concrete seawall, about 4.5 feet high and about 3/4 of a mile long. Twelve short groins extend from the seawall into the bay. The south part of the east shore of Lavaca Bay is low, undeveloped land. The remainder of the shore is comprised of banks and bluffs up to 25 feet high, except for some marsh areas at the mouths of several streams entering the bay. The City of Port Lavaca is the largest populated area on the bay. A considerable portion of the city's shore is protected against erosion from normal waves by bulkheads and rubble revetment.

Shoreline segments 74-86: The northeasterly end of the Gulf shore in this area is undeveloped. It is a remote area and not easily accessible. The area is used for camping, bathing, and fishing when beach travel conditions permit. The Cedar Lakes area is undeveloped. Some small Gulf shore areas near the mouth of Caney Creek are subdivided for beach homes. Matagorda Peninsula, southwest of the mouth of Caney Creek is used mostly for grazing. Numerous summer homes are located in the more accessible areas near the mouth of the Colorado River, where the beach is excellent for bathing and surf fishing. The shores of Matagorda Bay, east of the Colorado River are generally undeveloped.

Shoreline segments 87-90: Shoreline development of the eastern half of this zone consists of permanent and summer homes and recreation

oriented businesses which cater to the many fisherman and bathers who visit the beach. The City of Freeport and its adjacent heavily industrialized are are located here. The area westward of the Freeport Harbor navigation entrance is mostly undeveloped, since it is accessible only by a single road and a pontoon bridge across the Gulf Intracoastal Waterway. The beach does, however, receive some recreational use.

Shoreline segments 91-111: This zone includes the largest concentrations of shoreline development along the Texas coast. The large Galveston Bay System, comprising Galveston Bay, East Bay, Trinity Bay, West Bay and several smaller bay arms, lies behind the barrier formations of Bolivar Peninsula, Galveston Island an Follets Island. A considerable part of Bolivar Peninsula is occupied by permanent and summer residences and numerous commercial establishments. The City of Galveston occupies about the easterly one-third of Galveston Island and the westerly two-thirds of the island has many permanent and summer-home type residential developments. A number of similar developments are located on Follets Island, west of San Luis Pass. The westerly shore of Galveston Bay is occupied by almost continuous urban type developments from Texas City on the south to La Porte and Baytown on the north. Seabrook, Kemah, San Leon and a number of unincorporated communities from the bayshore in this reach. The City of Anahuac is located on the westerly shore of Trinity Bay near the mouth of the Trinity River. The Anahuac National Wildlife

Refuge borders about 6.5 miles to the north shore of East Bay.

The East Bay shoreline of Bolivar Peninsula is extensively used for recreational boating and fishing. The north shore of East Bay is mostly unoccupied except for residential development on Smith Point.

The shores of Trinity Bay are mostly undeveloped excepting the Anahuac vicinity and the vicinity of Umbrella Point and Houston Point on the north shore, where numerous homes, boating and fishing camps, and some oil industry facilities are located. The upper end of Galveston Bay near Baytown is highly developed. Most of the shores are occupied by industrial, commercial and residential properties. The Galveston Bay shoreline from Morgan Point to Texas City, including the shore of Clear Lake and some of Dickinson Bay, is extensively developed with permanent and summer residences and some commercial establishments. The shoreline outside of the Texas City Hurricane Flood Protection System is, for the most part, undeveloped. A few recreation oriented businesses are located in the unprotected area. The northerly shores of West, Rastrop and Christmas bays are undeveloped except for a few summer home type subdivisions.

Galveston Island has about 32 miles of Gulf shoreline which is used heavily for recreation. About 10 miles of the Gulf shore of the City of Galveston is protected by a massive concrete seawall. Most private property along the seawall is highly developed with hotels, motels, apartments, restaurants, tourist attractions and

other businesses. A few permanent residences are located immediately behind the seawall. Some beach bathing facilities, motels, concessions, amusements and trailer park are situated on the unprotected part of the beach in front of the seawall at the east end of the island. The north portion of the City of Galveston and the south shore of nearby Pelican Island are occupied by marine and industrial facilities related to fishing, shipping and offshore oil exploration. The westerly two-thirds of Galveston Island is unprotected from hurricane surges. The area is rapidly changing from sparsely settled grazing lands to subdivisions for summer and permanent homes. Follet's Island, west of San Luis Pass, is about nine miles long and is occupied by many permanent and summer homes.

Shoreline segments 112-124: The shores of this most easterly zone are mostly undeveloped. Within the city limits of Port Arthur on the northwest shore of Sabine Lake, there are some recreational developments, principally for boating and boat racing. Two small towns are located near the Gulf, south of Port Arthur. The westerly portion of the Gulf shore is used extensively for public recreation, although virtually no facilities have been provided for public use or access.

b. Louisiana

Forty-five percent of the State of Louisiana consists of coastal and floodplain wetlands (Louisiana Planning Corporation. 1972. Vol. 1., pp. 235-236). Of the 30 million acres of estuarine water and wetlands nationally, Louisiana has over seven million acres -- more than any other state. These wetlands are primarily located in the Mississippi River Valley. The coastal marsh zone occupies a broad band of land from the State's Texas to Mississippi borders along the Gulf of Mexico. (central Gulf, Graphic 5, Vol. 3) Within its boundaries are found a range of plant and animal ecosystems determined by fresh, brackish and salt waters. In these wetlands, and in the remainder of the coastal zone, lies the majority of Louisiana's people and industry. The activities of the people, their work and play, are closely tied to the use of the resources of the coastal zone (Louisiana Adv. Comm. Coastal Mar. Res, 1973a, p. 19).

The wetlands contain 80 percent of the manufacturing and some of the most valuable mineral resources of the region and of the United States. Large quantities of petroleum, natural gas, sulphur and salt are extracted. Together, activities of coastal and marine-related businesses provide more than 50 percent of Louisiana's tax revenues. Eighty percent of the State's population is located within the wetlands.

Opportunities for development offered by the Louisiana coastal area include the presence of rich oil and gas resources, agricultural lands, wildlife resources which support trapping and recreational activities,

valuable fishery resources, and the proximity of the Mississippi River which serves as an important transportation route. These opportunities have given rise to industrial, urban and agricultural development, which in turn have supported populations increases.

Table 9 indicates the land use in coastal Louisiana by acres. It can be seen that marshlands comprise 63 percent of the land area of the coastal parishes. These marshlands are essential habitat for numerous economically important species of fish and wildlife and are the site of wildlife refuges and game management areas.

The following discussion will cover the major components of the environment and their condition as they presently exist in the coastal zone. This discussion relies heavily on the work conducted at the Center for Wetland Resources at Louisiana State University (Gagliano, 1972) and the Atlas of Louisiana, Miscellaneous Publication 72-1 (Newton, 1972).

### Barrier Islands, Reefs and Gulf Shore Areas

These areas represent the first line of defense against storms and marine processes, regulating inflow and outflow of Gulf waters, are valuable as wildlife habitats and recreation areas. They are vulnerable to erosion and hurricane damage.

Barrier islands, reefs and gulf shore areas extend along the entire Louisiana coast except for that part of the Mississippi Delta lying seaward of a line extending southwest of Brenton Island.

There are two towns lying in this zone; Cameron in Southwest Louisiana, and Grand Isle in the Southeast. This zone also supports

Table 9 Land Use in Coastal Louisiana
(by No. of Acres)

| Parish | Total Area | Water Area | Marsh-land | Forest Land | Agri. Land | Urban Land | Trans-port | Aggre-gate Land Ar. | Unac-counted Acreage | Area Percent |
|---|---|---|---|---|---|---|---|---|---|---|
| Cameron | 1,087,360 | 194,101 | 739,474 | - | 269,492 | 180 | 2,332 | 1,011,478 | -118,210 | -10.9 |
| Iberia | 414,080 | 49,050 | 115,164 | 115,000 | 129,618 | 5,210 | 4,805 | 369,797 | -4,767 | - 1.2 |
| Jefferson | 382,720 | 136,960 | 157,237 | - | 7,379 | 24,030 | 2,838 | 191,484 | 54,276 | 14.2 |
| Lafourche | 865,920 | 168,239 | 390,742 | 156,000 | 179,339 | 3,320 | 3,884 | 733,285 | -35,604 | -4.1 |
| Orleans | 232,320 | 112,460 | 59,930 | - | 1,055 | 37,995 | 30,941 | 129,921 | -10,061 | -2.0 |
| Plaquemines | 895,360 | 322,788 | 494,101 | - | 53,658 | 4,515 | 2,321 | 554,595 | 17,977 | 2.0 |
| St. Bernard | 517,120 | 220,915 | 275,499 | - | 11,838 | 3,065 | 609 | 291,011 | 5,194 | 1.0 |
| St. Mary | 453,760 | 87,147 | 172,308 | 143,000 | 107,276 | 5,440 | 3,549 | 431,573 | 64,960 | -14.3 |
| Terrebonne | 1,144,320 | 314,883 | 621,118 | 122,400 | 73,183 | 5,730 | 5,027 | 827,458 | 1,979 | 0.2 |
| Vermilion | 844,800 | 97,927 | 402,807 | 31,600 | 372,439 | 3,520 | 8,214 | 818,580 | -53,707 | -6.4 |
| Totals | 6,837,760 | 1,686,470 | 3,428,380 | 568,000 | 1,205,277 | 93,005 | 64,520 | 5,359,182 | | |
| % of land in study area by type | | | 63% | 10.6% | 22% | 1.7% | 1.2% | 100% | | |

Data from State of Louisiana, 1967

numerous but isolated fishing and trapping camps.

Fresh, Intermediate, Brackish and Saline Marsh Areas

These areas are extremely important as habitat for fish and wildlife, are an important component of the estuarine zone, are important recreation areas, and serve as buffer zones against storm generated surges.

Marsh areas extend along the entire coastline of Louisiana. They lie behind the barrier islands, reefs and gulf shore areas, or front directly on the Gulf as along the outer parts of the Mississippi delta.

This area is used extensively for hunting, fishing and trapping, and supports many isolated base camps.

Estuarine Nursery Areas

These areas are the most biologically productive areas of the state, essential to the fisheries, and provide habitat for wildlife. This zone supports an extensive commercial as well as sport fisheries, the nature of which is more extensively discussed in other appropriate sections.

c. Mississippi and Alabama

Land use in the coastal counties of Mississippi and Alabama was described in the U. S. Army Corps of Engineers' Report on Gulf Coast Deepwater Port Facilities, 1973, and is presented below with only minor changes.

The total acreage for the five coastal counties of the two states was 2,988,000 acres in 1967. The land use for the area is shown in Table 10.

Table 10 1967 Land use information for Mississippi and Alabama.
(in 1,000 acres)

| State County | Area of County | Federal Non-cropland | Urban & Built-up 1/ | Small Water Areas 2/ | Cropland | Pasture | Forest | Other Land |
|---|---|---|---|---|---|---|---|---|
| Mississippi | | | | | | | | |
| Hancock | 310.4 | 13.5 | 26.2 | 6.4 | 13.5 | 11.0 | 212.8 | 27.0 |
| Harrison | 374.4 | 61.8 | 50.9 | 3.4 | 13.0 | 10.1 | 230.0 | 5.2 |
| Jackson | 476.2 | 22.4 | 60.8 | 7.3 | 14.0 | 20.5 | 316.5 | 34.7 |
| Subtotal | 1,161.0 | 97.7 | 137.9 | 17.1 | 40.5 | 41.6 | 759.3 | 66.9 |
| Alabama | | | | | | | | |
| Mobile | 794.9 | 3.6 | 100.3 | 3.1 | 68.5 | 37.5 | 561.3 | 20.5 |
| Baldwin | 1,032.1 | 2.8 | 31.7 | 6.9 | 157.6 | 26.7 | 759.8 | 46.6 |
| Subtotal | 1,827.0 | 6.4 | 132.0 | 10.0 | 226.1 | 64.2 | 1,321.1 | 67.1 |

1/ This includes cities, villages, built-up areas of more than 10 acres, industrial areas (except strip mines, borrow and gravel pits), railroad yards, cemeteries, airports, institutional and public administrative sites.

2/ This includes ponds and lakes of more than two acres but less than 40 acres, rivers and streams that are less than 1/8 mile wide.

3/ This includes non-Federal rural land which is not classified cropland, pasture, range or forest land.

Within the area, land use is divided along a line parallel to the coastline and a few miles inland. North of this line the land is undeveloped and rural with forests and farms constituting the principal land uses. South of this line are most of the urbanized areas. Urbanized areas are almost non-existent north of the line. This pattern is best exemplified by the Mississippi portion of the study area. Interspersed between the urbanized strips along the coast are a few isolated urban centers and large sections of uninhabited land which are barriers to urban growth; e.g., waterbodies and swamps. The central portion near Mobile is sparsely developed.

The greatest recent urban development has occurred contiguous to some of the major urban areas, including Pascagoula. Generally the coastal region has steadily expanded in urbanized land uses.

The three coastal counties of Mississippi would be a catenulate development from Waveland to Pascagoula. As it now exists, Pascagoula is entirely separated from the urban strip and almost from the shoreline, because of the natural barriers and undeveloped land. Most of the land in this State's coastal region is suitable for urbanization in the future. None of the three counties has an urban place outside the coastal region.

The principal urban area in Hancock County is Bay St. Louis. Most of the county is at present rural undeveloped (forestland). There has been some recent growth at Waveland and also along the shoreline west of Bay St. Louis. Two large planned communities are now under construction in the county and are expected to significantly affect land

use patterns and land values in the near future.

Harrison County has an urban strip for its entire coastline, which includes the Biloxi-Gulfport area. Biloxi and Gulfport contain the majority of the industrial, commercial and tourist facilities in the county. The upland section is predominantly forested and includes a large segment of the DeSoto National Forest. The location of the interstate highway inland from the coastal region will have a great impact on the area north of Biloxi as it nears completion. Recent growth along the shoreline between Gulfport and Biloxi has been predominantly commercial as a part of the reconstruction effort after Hurricane Camille.

Jackson County is expected to experience the greatest growth of the Mississippi coastal counties due to the phenomenal economic and industrial growth rates in Pascagoula. Land has been rapidly urbanized contiguous to Pascagoula and it is expected to continue this trend. The county is split almost equally into a western and an eastern section by the Pascagoula River and its lowlands, and this natural barrier extends for about five miles in places. The western half is largely undeveloped, the northern portion is mostly forested, and the southern portion of the coastline is not suitable for urban development. The eastern section is almost identical with the western portion except for the existence of Pascagoula.

The offshore islands are a valuable state asset, particularly for recreation. Cat Island is privately owned and is now being developed for residential use; Horn Island is now a national wildlife refuge,

and Ship Island, Horn Island, and Petit Bois Island are part of the Gulf Islands National Seashore development.

The coastal counties of Alabama are split north to south by the large natural barrier created by the lowlands of the Mobile, Middle, Apalachee and Blakely Rivers.

Urbanization in Mobile County has been limited to the Mobile Standard Metropolitan Statistical Area. The southern half of the county contains rural land uses, including large orchards; the northern half is rural and undeveloped, principally forestland.

Baldwin County is very similar in land use characteristics to Mobile County, with the exception that it has virtually no extensive urbanization. The lower half of the county does have a great deal of flat land which is conducive to farming operations.

The coastal region along Mobile Bay and the Gulf has not been heavily developed. Scattered dwellings exist on the peninsula that forms Bon Secour Bay and a few have recently been constructed adjacent to Gulf State Park and eastward to the new marina on the point at Arnica Bay.

Alabama's offshore islands are also a definite asset. Dauphin Island has been extensively developed and will continue to grow. The peninsula east of the island in Baldwin County is very similar in most aspects except it does not have extensive sand beaches on the Mobile Bay side.

Tables 11 and 12 , based on the U.S. Army Corps of Engineers National Shoreline Study, indicates the land use of the shoreline in

the area of concern (Stursa, 1973).

Table 11

MISSISSIPPI GULF COAST

| Land Use | Miles of Shoreline | Percent of Shoreline |
|---|---|---|
| Public Recreation | | 12.5 |
| Gulf | 0 | |
| Bay/Estuary | 31.0 | |
| Private Recreation | | 43.0 |
| Gulf | 6.9 | |
| Bay/Estuary | 99.0 | |
| Non-Recreational Developed | | 4.5 |
| Gulf | 0 | |
| Bay/Estuary | 9.5 | |
| Undeveloped | | 40.0 |
| Gulf | 26.3 | |
| Bay/Estuary | 74.3 | |

Table 12

ALABAMA GULF COAST

| | | |
|---|---|---|
| Public Recreation | | 9.0 |
| Gulf | 4.0 | |
| Bay/Estuary | 27.6 | |
| Private Recreation | | 65.0 |
| Gulf | 30.3 | |
| Bay/Estuary | 179.6 | |
| Non-Recreational Developed | | 1.5 |
| Gulf | 2.0 | |
| Bay/Estuary | 3.0 | |
| Undeveloped | | 24.5 |
| Gulf | 10.1 | |
| Bay/Estuary | 95.1 | |

d. Florida

"Florida has some 9,000 miles of shoreline. This shoreline and its adjacent warm coastal waters and amenable hinterland comprise a great natural resource, not only for the residents of Florida but also for the entire nation as well." (Florida Coastal Zone Land Use and Ownership. p. 3)

The coastal zone of Florida encompasses 27.6% of the state's land area and 74.7% of the state's 1972 population. ("Florida Population Analysis"). Although the entire coastal zone is experiencing development pressures, urban growth is occurring in only a few distinct pockets along the coast. There are still extensive sections of the coastal area which consist entirely of pine forests, inland swamps, and coastal marshes. Some of the counties have no urban places in the coastal zone.

The Florida Gulf Coastal Region, comprised of 25 counties, contains a total land area of 12,548,450 acres. In conjunction with the National Inventory of Conservation needs, the land of the state area was surveyed in 1969. According to the survey, 4.5 percent was classified as "urban and build up". Also, 9.4% of the area was federally-owned. The predominant land use was forest land encompassing 63 percent of the land area of the coastal region. Approximately 18 percent of the coastal region's land area was allotted to cropland, pasture and rangeland. The land use data from 1969 study relative to coastal counties is presented in Table 13.

Table 14 based on the U.S. Army Corps of Engineers' National

Table 13

# FLORIDA LAND DISTRIBUTION 1967

| County | Total Acres | NON-INVENTORIED ACRES: Federal New Cropland | NON-INVENTORIED ACRES: Urban Built-Up | NON-INVENTORIED ACRES: Small Water Areas | INVENTORIED ACRES: Cropland | INVENTORIED ACRES: Pasture | INVENTORIED ACRES: Range | INVENTORIED ACRES: Forest | INVENTORIED ACRES: Other |
|---|---|---|---|---|---|---|---|---|---|
| Escambia | 420,480 | 9,750 | 54,648 | 395 | 51,480 | 5,106 | 0 | 289,291 | 9,810 |
| Santa Rosa | 655,360 | 70,080 | 9,200 | 1,199 | 65,952 | 6,943 | 0 | 492,875 | 9,111 |
| Okaloosa | 604,160 | 246,068 | 7,816 | 3,476 | 36,058 | 10,242 | 0 | 295,000 | 5,500 |
| Walton | 668,770 | 151,446 | 19,479 | 1,500 | 43,718 | 17,256 | 0 | 419,454 | 15,917 |
| Holmes | 309,120 | 109 | 5,714 | 1,194 | 67,945 | 38,660 | 0 | 190,800 | 4,698 |
| Bay | 481,920 | 30,000 | 26,000 | 1,998 | 4,823 | 5,394 | 0 | 399,000 | 14,705 |
| Gulf | 356,480 | 962 | 6,460 | 3,340 | 1,786 | 1,500 | 4,100 | 329,000 | 9,332 |
| Franklin | 348,160 | 21,828 | 7,517 | 2,113 | 80 | 350 | 4,000 | 290,700 | 21,572 |
| Wakulla | 392,960 | 221,918 | 5,013 | 1,824 | 30,788 | 10,000 | 0 | 103,182 | 20,235 |
| Jefferson | 382,720 | 8,183 | 5,598 | 2,512 | 88,784 | 25,000 | 0 | 248,700 | 3,943 |
| Taylor | 660,480 | 1,201 | 7,869 | 5,258 | 13,900 | 22,000 | 0 | 589,300 | 20,952 |
| Dixie | 440,320 | 74 | 4,021 | 3,865 | 7,735 | 6,672 | 20,354 | 395,600 | 1,999 |
| Levy | 705,920 | 0 | 1,605 | 7,845 | 68,125 | 72,090 | 16,082 | 528,300 | 11,873 |
| Citrus | 364,800 | 10,984 | 10,500 | 3,533 | 14,150 | 33,762 | 31,542 | 233,300 | 27,029 |
| Hernando | 312,320 | 11,003 | 7,800 | 4,145 | 17,796 | 37,295 | 15,794 | 209,000 | 9,487 |
| Pasco | 480,640 | 0 | 6,500 | 8,364 | 58,174 | 62,439 | 70,290 | 264,900 | 9,973 |
| Pinellas | 168,960 | 570 | 69,229 | 1,801 | 10,890 | 5,797 | 4,500 | 59,400 | 11,773 |
| Hillsborough | 665,600 | 5,982 | 68,226 | 8,231 | 101,307 | 110,579 | 35,788 | 288,400 | 47,087 |
| Manatee | 448,640 | 67 | 38,360 | 7,504 | 31,311 | 50,430 | 13,879 | 286,000 | 21,089 |
| Sarasota | 375,040 | 49 | 46,430 | 904 | 5,400 | 40,199 | 25,076 | 227,300 | 29,682 |
| DeSoto | 414,720 | 12 | 3,405 | 485 | 34,569 | 54,296 | 152,153 | 168,800 | 1,000 |
| Charlotte | 451,200 | 246 | 44,730 | 2,940 | 18,206 | 33,586 | 37,932 | 279,300 | 34,260 |
| Lee | 503,340 | 2,542 | 43,646 | 6,208 | 51,732 | 35,103 | 15,030 | 303,300 | 45,479 |
| Collier | 1,300,480 | 28,064 | 26,374 | 293 | 70,174 | 30,000 | 195,132 | 886,436 | 64,007 |
| Monroe | 636,160 | 355,399 | 32,302 | 2,000 | 0 | 0 | 0 | 127,643 | 118,816 |
| Florida Coastal Region | 12,548,450 | 1,176,537 | 558,442 | 82,927 | 894,883 | 714,699 | 641,652 | 7,904,981 | 574,329 |

Source: <u>Conservation Needs Inventory</u>, Florida Department of Agriculture and Consumer Service, 1969

shoreline study indicates the land uses of the shoreline in the area of concern.

Table 14. Shoreline Land Use in the Coastal Zone

FLORIDA GULF COAST

| Land Use | Miles of Shoreline | Percent of Shoreline |
|---|---|---|
| Public Recreation | | 5 |
| Gulf | 101 | |
| Bay/Estuary | 66 | |
| Private Recreation | | 17 |
| Gulf | 165 | |
| Bay/Estuary | 449 | |
| Non-Recreational Developed | | 20 |
| Gulf | 85 | |
| Bay/Estuary | 678 | |
| Undeveloped | | 58 |
| Gulf | 417 | |
| Bay/Estuary | 1,706 | |

2. Ocean Dumping Areas and Military Use

a. Ocean dumping

Ocean dumping under the 1972 Marine Protection Research and Sanctuaries Act is regulated by permits issued by the United States Environmental Protection Agency. In May, 1973, a list of approved interim dumping sites was published in the Federal Register. Table 15 shows those approved interim sites located in the Gulf of Mexico.

To date, two permits have been issued for dumping of industrial chemical wastes; one to Texas Shell Chemical Company and another to Louisiana Ethyl Corporation. An additional site was cleared for incineration of chemical wastes by Shell Chemical Company. The geographic coordinates of these three sites are as follows:

Texas Shell Chemical Company

27°12' N - 27°28' N; 92°28' W - 94°44' W (312,160 Ac)

Louisiana Ethyl Corporation

28°00' N - 28°10' N; 89°15' W - 89°30' W (86,400 Ac)

Shell Chemical Company (Incineration Site)

26°20' N - 27°00' N; 93°20' W - 94°00' W (823,680 Ac)

Table 15.

Approved Interim Dumping Sites - EPA Region IV

| Location | Size (Square miles) | Depth (Feet) | Primary Use |
|---|---|---|---|
| South of Pascagoula, Miss. 30 12', 88 33' | 0.20 | 30-40 | Dredged materials (hopper dredge) |
| South of Panama City, Fla. 30°07', 85°40' | 0.50 | 40 | Do. 1/ |
| Port St. Joe, Fla. 29°50' 85°29' | 0.10 | Unknown | Do. |
| Port St. Joe, Fla. 29°53', 85°31' | 0.15 | Unknown | Do. |
| South of Carrabelle, Fla. 29°41', 84°37' | 1.00 | 36-42 | Do. |
| South of Carrabelle, Fla. 29°40', 84°39' | 1.00 | 36-42 | Do. |
| 31°40', 76°56' | 2/ | 7,600 | Conventional munitions |

1/ Ditto
2/ Three-mile radius

Source: Federal Register, Vol. 38, No. 94, Wednesday, May 16, 1973

Table 15 (continued)

Approved Interim Dumping Sites - EPA Region IV

| Location | Size (Square miles) | Depth (Feet) | Primary Use |
|---|---|---|---|
| Charlotte Harbor<br>26°39', 82°19' | 0.70 | 29 | Silty sand and shell |
| Tampa Harbor<br>27°36', 82°45' | 0.50 | 28 | Poorly graded sand and shell |
| Tampa Harbor<br>27°33', 82°51' | 0.90 | 32 | Do. |
| Tampa Harbor<br>27°38', 82°51' | 0.90 | 24 | Do. |
| South of Mobile, Ala.<br>30°10', 88°06' | 0.80 | 44-48 | Dredged materials (hopper dredge) |
| Southeast of Gulfport, Miss.<br>30°10', 88°57' | 0.50 | 23-32 | Do. |
| Southeast of Gulfport, Miss.<br>30°10', 89°00' | 0.40 | 23-32 | Do. |
| South of Pensacola, Fla.<br>30°17', 87°19' | 0.10 | 36-42 | Do. |

continued

Table 15 (continued)

Approved Interim Dumping Sites - EPA Region VI

| Location | Size (Square miles) | Depth (Feet) | Primary Use |
|---|---|---|---|
| Calcasieu Pass, Area A $29^{\circ}45'$, $93^{\circ}21'$ | 1.00 | 6+ | Dredged materials |
| Calcasieu Pass, Area B $29^{\circ}45'$, $93^{\circ}20'$ | 1.00 | 6+ | Do. |
| Calcasieu Pass, Area C $29^{\circ}42'$, $93^{\circ}21'$ | 5.00 | 18+ | Do. |
| Calcasieu Pass, Area D $29^{\circ}35'$, $93^{\circ}17'$ | 5.00 | 18+ | Do. |
| Southwest Pass $28^{\circ}52'$, $89^{\circ}31'$ | 2.00 | 45+ | Do. |
| Waste Disposal Area $27^{\circ}44'$, $94^{\circ}44'$, $27^{\circ}28'$, $94^{\circ}28'$ | 16 mi. by 16 mi. | 2,400 | Chemical wastes |
| Waste Disposal Area $28^{\circ}0'$, $28^{\circ}20'$, $89^{\circ}15'$, $89^{\circ}35'$ | 20 mil by 20 mi. | 2,400+ | Do. |
| Off Sabine Pass, Tex., Area A $29^{\circ}37'$, $93^{\circ}50'$ | Approx. 5 | 24 | Dredged materials |

continued

Table 15 (continued)

Approved Interim Dumping Sites - EPA Region VI

| Location | Size (Square miles) | Depth (Feet) | Primary Use |
|---|---|---|---|
| Off Sabine Pass, Tex., Area B 29°37', 93°48' | Approx. 3 | 30 | Do. |
| Off Sabine Pass, Tex., Area C 29°40', 93°51' | Approx. 4 | 6 | Do. |
| Off Galveston, Tex., Area A 29°19', 94°40' | Approx. 2.5 | 36 | Do. |
| Off Galveston, Tex., Area B 29°20', 94°39' | Approx. 2.5 | 30 | Do. |
| Off Galveston, Tex., Area C 29°17', 94°40' | Approx. 7 | 36 | Do. |
| Off Galveston, Tex., Area D 29°22', 94°43' | Approx. 8 | 12 | Do. |

Source: Federal Register, Vol. 38, No. 94, Wednesday, May 16, 1973

b. Military uses of the continental shelf

The Gulf of Mexico is used rather extensively by the Navy and Air Force for conducting military training, testing and research activities. These current activities consist of missile testing, ordnance testing, drone recovery operations, pilot training and electronic counter measure (ECM) activities by the Air Force. Mine research activities are conducted by the Department of Navy. Most of this activity takes place in areas designated for these purposes. However, live ordnance testing by the Air Force occasionally involves emergency release of ordnance outside designated bombing areas. These ordnances range from small munitions to 1200-pound bombs. The possibility of occurrence of unexploded munitions on the ocean floor in the proposed sale area is not remote in certain locations. Potential for interference with military training and testing activities and possible hazards of unexploded munitions are discussed below.

The area of most concern in terms of conflicts with testing and training activities is Defense Warning Area W-151(Fig.20.1) off the northwest Florida Gulf coast. Missile testing, ECM activities, low level supersonic flights and drone recovery operations are conducted in the area by Eglin and Tyndall Air Force Bases.

In addition to the potential for interference with the military activities mentioned above, there is also a potential hazard from the release of hung ordnance in two "salvo areas" resulting in

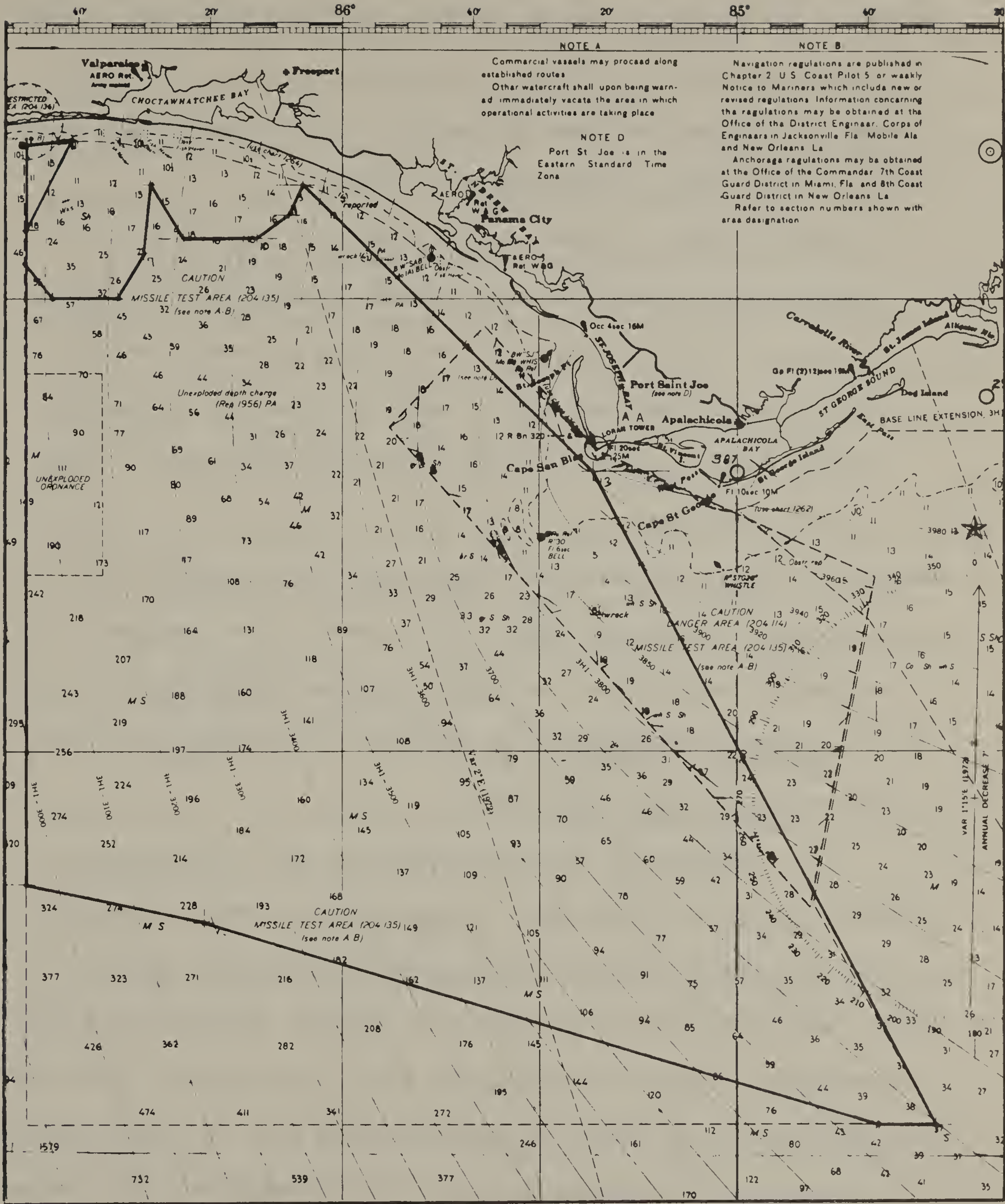



Figure 20.1    Defense Warning Area W-151

Source:  Flight Information Publ. AP/1A
         Defense Mapping Agency Aerospace Center, St. Louis

unexploded munitions on the ocean floor. Practice bombing is conducted on the military reserve at Eglin Air Force Base and occasionally ordnances fail to release. Two areas are set aside for the release and disposal of these ordnances, one for summer and one for winter. These areas are described as follows:

> A ten-mile-wide corridor along the western edge of W-151 beginning at a point 30 miles south of Santa Rosa Island and extending 63 miles south, is used during the winter months. Approximately one year ago, a salvo area for use during the summer months was established 15 nautical miles east of the winter salvo area.

When water ranges are used for jettisoning hung ordnance, the ordnance will be released armed. In the event of an emergency (for example, radio failure or flight problems) which precludes the use of a salvo area designated by ADTC, the flight will be cleared to drop ordnance on any water range.

Because Air Force procedures provide for dropping ordnance over water in the event of an emergency which precludes the use of a designated salvo area, potential hazards, however remote, exist in every tract within the defense warning area W-151. Such emergencies have occurred in the past, and ordnances have been jettisoned as far shoreward as Choctawhatchee Bay. No quantification as to the amount of ordnance located in and outside the salvo areas was available.

The Navy has conducted no munitions dumping in water less than 500 fathoms in depth since 1945 which would place their current dump sites well outside the area of concern. Additional information received from the Office of the Oceanographer of the Navy revealed that all deepwater dump sites used by the Navy are located off the Atlantic and Pacific coasts and that no sites are utilized in the Gulf of Mexico.

The Air Force owns or leases approximately 50,000 acres on Matagorda Island which were used for a variety of military purposes. All of this property has been determined to be excess to the requirements of the DoD. Disposal of this property has been cleared with the Congressional Armed Services Committees and a Report of Excess is being prepared for forwarding to the GSA. All military uses of this property ceased as of June 30, 1975. Action is currently underway to clear the propoerty of unexploded ordnance and ordnance residue. (U. S. Department of Defense 1975).

Previously a coordinated fish and wildlife management plan was instituted on those lands under Air Force administration which were not intensively used to support military activities. The management purpose was to provide protection for rare and endangered species and non-game species and to provide recreation through hunting and fishing.

### 3. Recreation and Allied Resources

The northern Gulf of Mexico coastal zone is one of the major recreational areas of the U. S., particularly in connection with salt-water fishing and beach-oriented activities.

There is considerable diversity in natural landscapes from the semi-arid beaches of south Texas through the marshes of Louisiana to the coral keys of Florida. Large numbers of visitors are attracted from outside the region by these natural conditions, as well as the sub-tropic climate.

Public parks and preserves provide opportunities for hunting, fishing, camping, wildlife viewing and photography. Commercial recreation facilities are very important as well, and include ornamental gardens, marinas and a variety of resorts and services.

The long and colorful history of the Gulf South has provided a rich legacy in architectural forms, historic sites and historic districts. The prehistoric record of archaeological remains in this area is also large and continually expanding through discovery and research.

#### a. Sport fishing

A salt-water angling survey conducted by the National Marine Fisheries Service in 1970 provides the most recent comprehensive sport fishing statistics for the Gulf of Mexico (Deuel, 1973). Graphic 5 for each of the western, central and eastern Gulf areas displays coastal zone and offshore fisheries. Also of interest in this connection will be graphic 4 showing undersea features.

The area was divided into the East Gulf from the Florida

Keys to and including the Mississippi River delta and the West Gulf from the Mississippi to the Mexican border.

Table 16 summarizes the results of this study and provides comparisons between U.S. coastal regions and with earlier time periods. It was estimated that 1,478,000 salt-water anglers were active in the eastern Gulf of Mexico and 872,000 in the western Gulf in 1970. For the combined Gulf areas 287 million fish weighing 486 million lbs. were landed by 2.35 million sport fisherman. Table 17 shows the dominance of the eastern Gulf in the number of fishermen and total catch. Methods of fishing are proportionally consistent between the east and west Gulf, except that in the west, charter and party boat fishing makes up a smaller share and beach-bank-bridge-pier-jetty fishing a higher proportion of total activity than in the east. Detailed information on sport fishing activity, catch and value is not uniformly available for the Gulf of Mexico, although research is underway which should improve this situation soon. The National Marine Fisheries Service has established two sport fishing laboratories in the Gulf area and has undertaken, with their port sampling of commercial products, the gathering of sport fishing data. A number of sport fishing studies are underway in Texas bays by the Texas Parks and Wildlife Department and the University of Texas. Also, the National Marine Fisheries Service recently began a creel census of salt-water fishing along the south Texas coast, and a study of the West Bay area near Florida.

Table 16

ESTIMATED NUMBER OF SALTWATER ANGLERS AND THEIR CATCHES IN THE UNITED STATES IN 1960, 1965, AND 1970, BY SURVEY REGION

| Region | Number of Anglers (000) | | | Number of Fish Caught (000) | | | Weight of Fish Caught (000) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1960 | 1965 | 1970 | 1960 | 1965 | 1970 | 1960 | 1965 | 1970 |
| I. North Atlantic (New England and New York) | 1,160 | 1,530 | 1,666 | 97,383 | 172,660 | 117,014 | 183,740 | 316,360 | 267,451 |
| II. Middle Atlantic (New Jersey to Cape Hatteras) | 1,344 | 1,375 | 1,767 | 114,502 | 92,126 | 168,209 | 178,000 | 128,288 | 246,267 |
| III. South Atlantic (Cape Hatteras to Florida Keys) | 1,024 | 1,720 | 1,808 | 156,942 | 190,802 | 184,177 | 370,112 | 391,833 | 403,913 |
| Gulf of Mexico 1/ (Florida West Coast to Texas) | 1,412 | -- | -- | 184,582 | -- | -- | 411,110 | -- | -- |
| IV. East Gulf of Mexico (Florida West Coast to Mississippi River) | -- | 1,234 | 1,478 | -- | 104,551 | 188,888 | -- | 187,957 | 334,120 |
| V. West Gulf of Mexico (Mississippi River to Texas) | -- | 738 | 872 | -- | 89,550 | 97,708 | -- | 187,618 | 151,608 |
| VI. South Pacific (Pt. Conception South) | 687 | 978 | 894 | 50,064 | 48,542 | 37,221 | 154,120 | 176,828 | 94,234 |
| VII. North Pacific (Pt. Conception North) | 714 | 999 | 1,311 | 29,399 | 38,508 | 24,100 | 83,219 | 85,469 | 79,230 |
| All Regions | 6,198 2/ | 8,236 2/ | 9,392 2/ | 632,872 | 736,739 | 817,317 | 1,380,301 | 1,474,353 | 1,576,823 |

1/ The Gulf of Mexico was not separated into East and West sampling regions for the 1960 Angling Survey.
2/ These figures are less than the sum of anglers for the individual regions because some anglers fished in more than one region.

Table 17

## Salt-Water Fishermen and Their Catches[1/] by Principal Area and Method of Fishing - 1970

| Region | Principal area of Fishing | | Principal methods of fishing | | | |
|---|---|---|---|---|---|---|
| | Ocean | Sounds, rivers, and bays | Private or rented boats | Party or chartered boats | Bridge, pier, or jetty | Beach or bank |
| | Thousands | | | | | |
| East Gulf of Mexico: | | | | | | |
| Number of fishermen... | 633 | 915 | 607 | 323 | 413 | 266 |
| Number of fish caught. | 42,352 | 146,536 | 87,328 | 39,892 | 40,735 | 20,933 |
| Total weight ........ | 111,177 | 222.943 | 167,875 | 75,638 | 69,793 | 20,814 |
| West Gulf of Mexico: | | | | | | |
| Number of fishermen... | 341 | 477 | 284 | 101 | 288 | 198 |
| Number of fish caught. | 47,173 | 50,535 | 56,684 | 4.425 | 23,236 | 13,363 |
| Total weight ........ | 64,800 | 86,808 | 85,805 | 8,579 | 33,024 | 24,200 |

1/ The number of fish caught and the weight of fish caught in the two principal areas of fishing are equal to the total catch for a region, and the number and weight caught by the four methods of fishing are equal to the total catch for a region. However, the number of anglers in not additive as some anglers fished in both areas and by more than one method for certain species groups in a particular region.

Source: (Deuel, 1973)

Salt-water sport fishing is very important in Florida. According to Taylor, the sport fishing "industry" earned $350 million in 1971 and had been growing at an annual rate of $25 million per year (Taylor et al., 1973). Man-days spent in salt-water sport fishing in 1971 were estimated at 8,800,000. No breakdown in the statistics was made between the Atlantic and Gulf coasts of Florida, but the Florida Department of Natural Resources estimated in 1972 that over 50 percent of the salt-water sport fishing in Florida can be attributed to the Gulf coast.

Sport fishermen in the northeastern Gulf have access to fishing in a variety of ways. Boats, both private and rented, are most popular, and many are served by party or charter boats. The Florida Department of Natural Resources lists 105 "head" or party boats located along the Florida Gulf coast (Florida Dept. Nat. Res., no date).

Party boat fishing is characterized by the use of a large boat in the range of 55 to 65 feet carrying a large number of people. Bottom fishing consumes the majority of fishing time, although less often drift fishing and trolling methods are used. Party boats usually charge a set fee per person (per "head") and may require a certain minimum number of passengers aboard before they make a trip.

Charter boat fishing is characterized by the use of a smaller boat, about 30 to 45 feet in length, carrying up to 6 or 8 persons. Trolling is the primary method used. Along the Florida Gulf coast are listed 443 charter boats, and in the same area there are 46 public fishing piers. Although statistics are not available to indicate the intensity of use of fishing piers as differentiated from boat fishing, it is apparent from the number of fishing piers and from the number of people observed using them that this is a very popular means of fishing.

It is estimated that approximately 80% of all fishing activity occurs within twelve miles of shore (U.S. Dept. of Commerce, 1973b). A further rationale for the location of this twelve-mile line was the consideration of the maximum distance a party or charter boat can travel and return to shore in one day and allow adequate time for fishing in place of anchor.

Although fishing grounds are located throughout the northeastern Gulf, the most heavily fished areas are found offshore between Pensacola and Panama City and offshore between St. Petersburg and Sarasota. Major fishing grounds are shown and data for sport fishing user-occasions in Florida is present in terms of zones (Moe, 1970) on the following map (Fig. 21.).

Upper West Coast: (Carabelle to Bradenton). This region roughly corresponds to Recreation Planning Regions II, III, V, and VII. This is Florida's most important sport fishing region with 25,244,150 user occasions reported for this activity in 1970. (These include user

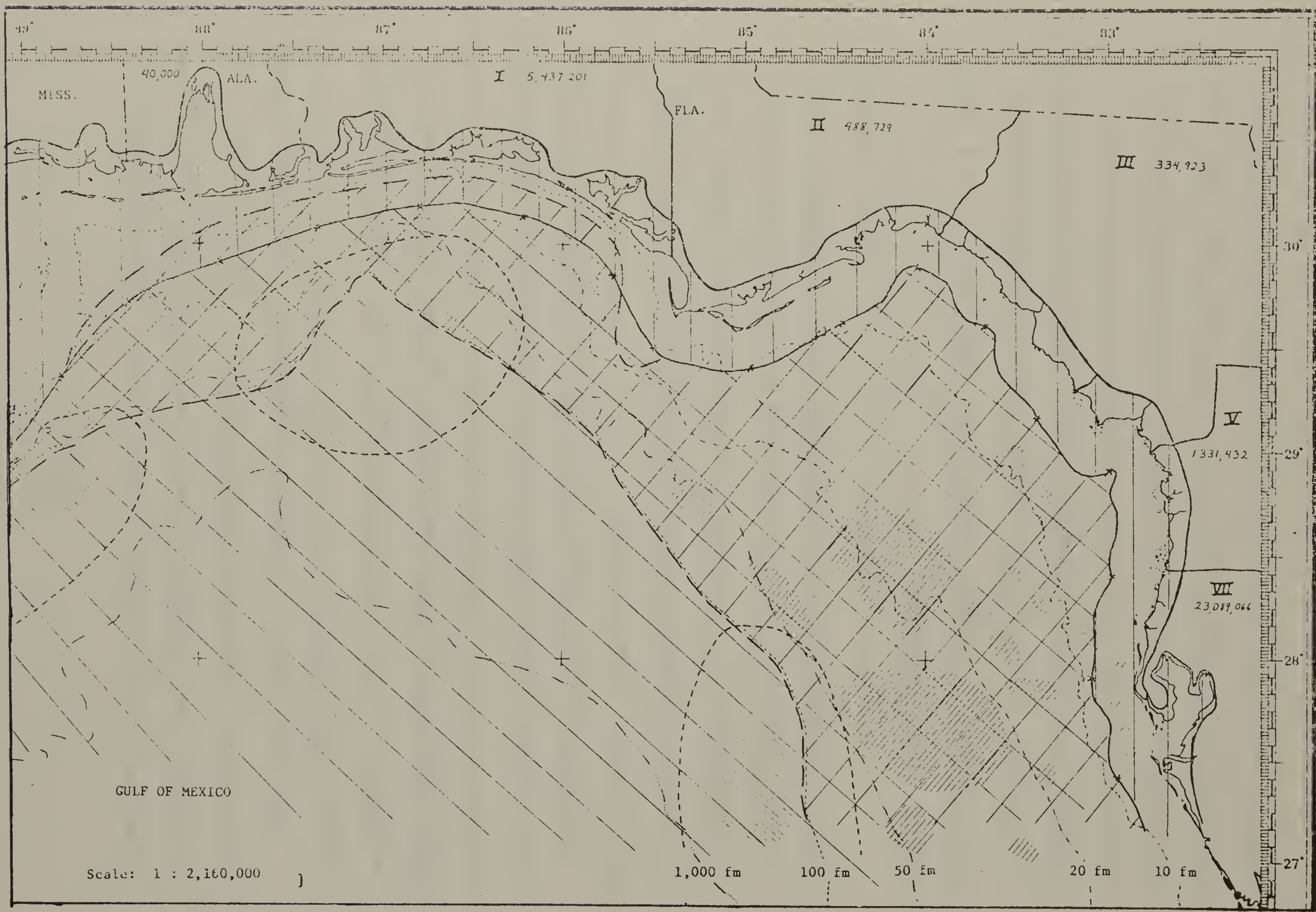



Figure 21. Sport-fishing data.

Figure 21 Legend: Sport Fishing

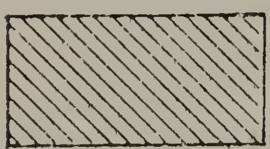
 Seaward limit (12 miles) of most heavily fished area

 Inshore and Coastline fish habitat and Fishery

 Reef and other oceanic fish habitat and fishery

 Bill fish habitat 

 Reef and other oceanic fish intensively fished

 Bill fish, area of greatest catch

Roman numerals indicate Recreation Planning Region.

Arabic numerals indicate user occasions.

occasions for the Sarasota area which is somewhat south of the region described.) Of this total, more than 23,000,000 is represented by St. Petersburg-Sarasota area (Dept. of Natural Resources, 1971). The region from Apalachicola to Tarpon Springs has the most favorable weather for fishing and greatest tourism coincident with the spring and summer months. There is very little offshore fishing activity during the winter months. Pinellas County (St. Petersburg area) also has heavy fishing pressure during the summer, but the impetus of tourism results in substantial fishing activity in the winter also. Tarpon, redfish, king mackerel, snook, spanish mackerel, cobia, sea-trout groupers and bill fish are among those fish caught in this area.

Northwest Coast: This zone extends from Pensacola to south of Panama City and roughly corresponds to the State Recreation Planning Region I (Dept. of Natural Resources, 1971). The most sought after and most numerous fish in the catch of sport and commercial vessels is the red snapper. Rocky areas, wrecks of ships and other irregularities of the bottom are the most productive. In the eastern section of the area, there is often a coral growth on the exposed rock as well as other invertebrate organisms. The dominant species taken by the party and commercial boats in this area include: red snapper, black grouper, vermillion snapper, scamp, porgy and the red grouper. During 1970 the number of user occasions for saltwater sportfishing in this region was reported to be 5,347,201 (Dept. of Natural Resources, 1971).

Alabama: Volume 19 of Alabama's State Comprehensive Outdoor Recreation Plan provides a detailed examination of Alabama sport fishing (Alabama SCORP, 1973a).

Recreation District 8 is made up of Baldwin and Mobile counties on the coast and Escambia, an adjacent inland county. Statistics for 1971 show that 3,097,934 fishing occasions took place in this district with out-of-state visitors contributing 400,000 of these occasions.

Freshwater fishing areas, both pubic and private, in District 8 total over 144,00 acres.

Alabama's coastal waters total 504,873. These waters are not a part of the surface acreage of the state but are under its jurisdiction and control subject to certain federal requirements. However, a sport fishing license is not required for fishing in these waters.

Coastal waters of Alabama may be divided into five estuarine areas and the portion of the Gulf of Mexico under state jurisdiction. The estuarine areas are: Mobile Delta (portion), Mobile Bay, Mississippi Sound, Little Lagoon and Perdido Bay. Combined, the five estuaries of Alabama have almost 675 square miles of open water and marshland (Table 18). The volume of open water is a massive 3.8 million acre-feet. This water area is surrounded by 433 miles of bay shoreline.

Table 18 ACREAGE OF WATER AND MILES OF SHORELINE, FIVE ESTUARIES, ALABAMA, 1971

| Estuarine Area | Open Water (Acres) | Marsh-land (Acres) | Total Surface Area (Acres) | Volume Of Open Water (Acre-ft) | Shoreline Distance Of Bays (Miles) |
|---|---|---|---|---|---|
| Mobile Delta | 20,323 | 15,257 | 35,580 | 166,368 | 55.4 |
| Mobile Bay | 264,470 | 6,224 | 270,694 | 2,585,446 | 142.4 |
| Mississippi Sound | 92,702 | 11,762 | 104,464 | 935,686 | 125.0 |
| Little Lagoon | 2,587 | 299 | 2,886 | 10,312 | 18.7 |
| Perdido Bay | 17,271 | 1,072 | 18,343 | 135,677 | 91.5 |
| TOTAL | 397,353 | 34,614 | 431,967 | 3,833,489 | 433.0 |

Mississippi: A recent thesis study of sport fishing in Biloxi Bay and adjacent Mississippi Sound provides the most detail available on Mississippi saltwater sport fishing (Jackson, 1972). In the period of July 1, 1971, to December 31, 1971, it was found that 29 species appeared in the sport catch. Four species are considered to be freshwater forms and the greatest number of estuarine or marine fishes caught belong to the family Sciaenidae. The most common species in the sport catch was the sand seatrout which accounted for 36.42 percent of the total followed by the Atlantic croaker (27.84 percent),

the spotted seatrout (14.88 percent), and the southern kingfish (7.02 percent). These fish were caught using a variety of baits and methods. Still fishing with live shrimp was the most popular method employed during the most of the year, but trolling with shrimp and minnows became very popular during the late fall. The two neighboring counties, Jackson County and Harrison County, accounted for 83.06 percent of the anglers encountered in boats. Anglers on piers spent 3.66 hours fishing per day and caught an average of 2.45 fish per hour. Fisherman on boats spent 5.13 hours fishing and had a catch rate of 2.04 fish per hour. The Biloxi Bay estuary was utilized by 23,499 fishermen in boats, and the estimated total catch during the six month study was 273,357 fishes. The greatest amount of the pressure occurred in October (31.42 percent) and the least pressure was in December.

In Mississippi, fishing ranks first in annual outdoor recreation activity occasions engaged in by residents and second only to swimming in summertime participation according to the Mississippi State Comprehensive Outdoor Recreation Plan, 1969 (SCORP).

The Mississippi Gulf Coast District comprises six counties; Hancock, Harrison, and Jackson facing Mississippi Sound, and Pearl River, Stone, and George counties lying adjacent inland. In this district freshwater fishing acreage ranks lowest of the state's districts with 6.18 acres per 1,000 population; however, saltwater fishing opportunities are excellent in Biloxi, Pascagoula and St. Louis bays, Mississippi Sound and the Gulf of Mexico beyond.

Approximately 3,500,000 saltwater fishing occasions were experienced by Mississippi residents in 1967. The location of this activity was not specified; however, it can be assumed that the majority of occasions would occur in Mississippi coastal waters and occasions taking place in other saltwater areas may be balanced by non-resident visitors to the Mississippi waters.

SCORP also reports 104 launching ramps and 41 marinas in this district offering facilities and storage space for 1,683 boats.

Louisiana: Sport fishing in Louisiana is a very popular form of recreation. Coastal marshlands with few roads reaching the shoreline has limited fishing access and precluded full utilization of the salt-water fishery resources. Nevertheless, man-days of fishing effort and pounds of catch are impressive. The data used here to portray the intensity of use of Louisiana's sport fishing resource is based on an unpublished report of the results of a telephone survey of 2,270 Louisiana households by the Bureau of Sport Fisheries and Wildlife. The study area was divided into nine hydrologic sub-basins as described in Table 19 and portrayed in Figure 22 Data is for the 1968 season.

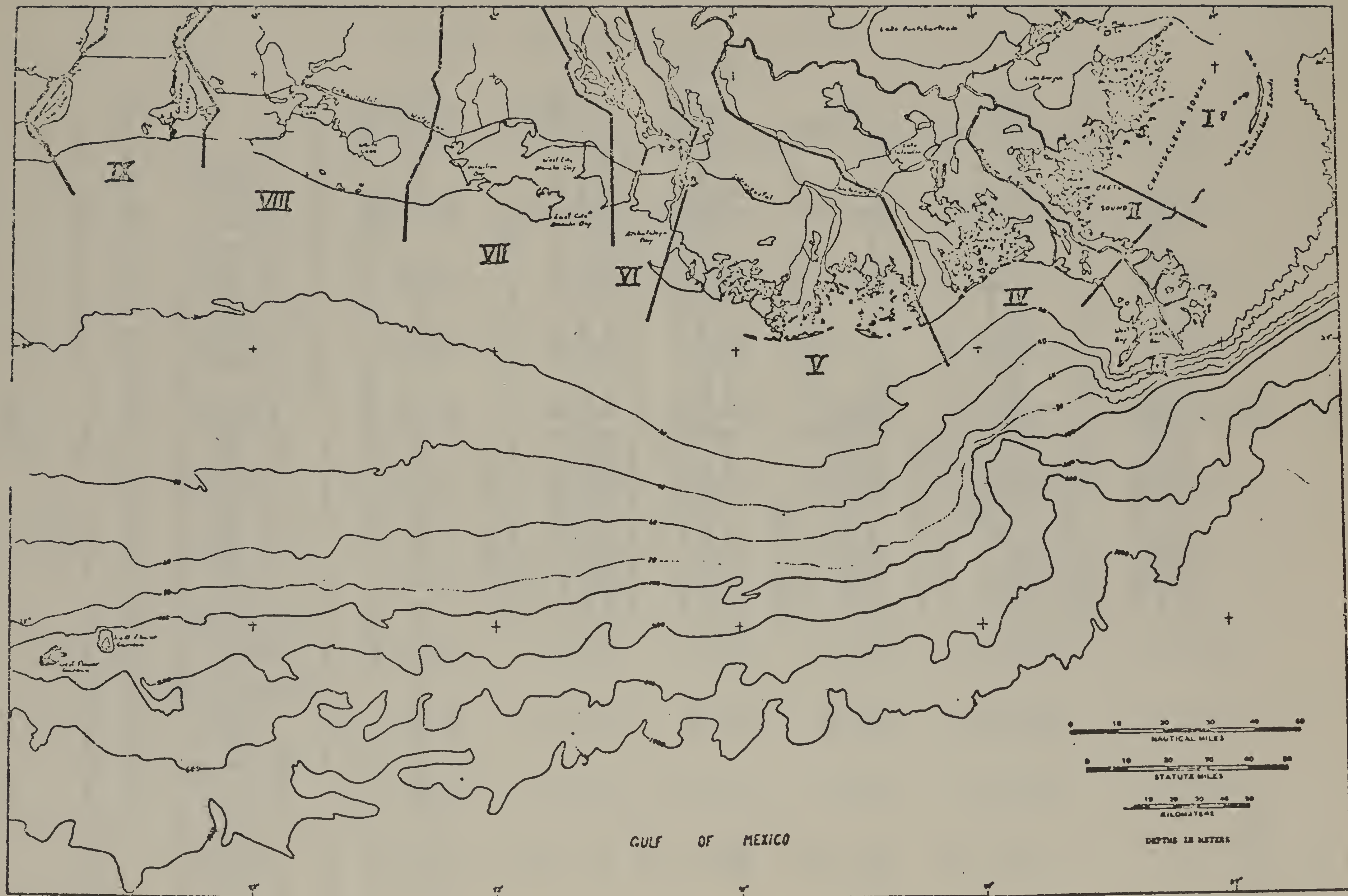



Figure 22 Hydrologic Sub-basins of the Louisiana Coast.

Table 19

| Sub-basin | Area |
|---|---|
| I | The area between Pear River and Bayou Terre aux Boeuf including Lake Maurepas and Lake Pontchartrain. |
| II | The area between Bayou Terre aux Boeuf to the Mississippi River. |
| III | The active Mississippi River Delta south of Bayou Baptiste Coullette and Red Pass. |
| IV | The area between the Mississippi River and Bayou Lafourche. |
| V | The area between Bayou Lafourche and the Atchafalaya River. |
| VI | The area between the Atchafalaya River and Bayou Sale. |
| VII | The area between Bayou Sale and along the drainage basin line in the vicinity of Freshwater Bayou and northward to Abbeville and Lafayette. |
| VIII | The area between Freshwater Bayou and the eastern drainage basin for the Calcasieu. This line approximates the line formed by State Highway 27 and north to Iowa, Louisiana. |
| IX | The area of the Calcasieu and Sabine drainage basins. |

Table 20 gives man-days and pounds of catch by sub-basin and type of fishing activity. Included are both freshwater and saltwater sport fishing. From this table the success or pounds per man-day effort can be derived. In order of yield, Sub-basin III ranks first with II, VII, I, IV, and VI in descending order. The average for all sub-basins is 7.2 pounds per man-day of fishing effort.

As indicated on Table 20 saltwater finfishing activities are most concentrated in Sub-basin I and IV. Some of the more popular salt-

Table 20. 1968 Sport Fishing - Louisiana

| | ACTIVITY | | | | | |
|---|---|---|---|---|---|---|
| | SPORT FINFISHING SALTWATER | SPORT FINFISHING FRESHWATER | SPORT CRABBING | SPORT CRAYFISHING | SPORT SHRIMPING | TOTALS |
| SUB-BASIN I | | | | | | |
| MAN-DAYS | 1,730,000 | 768,000 | 172,000 | 21,000 | 60,000 | 3,751,000 |
| POUNDS | 10,380,000 | 1,536,000 | 15,236,000 | 105,000 | 3,000,000 | 30,257,000 |
| SUB-BASIN II | | | | | | |
| MAN-DAYS | 101,000 | 26,000 | 27,000 | 9,000 | 18,000 | 181,000 |
| POUNDS | 606,000 | 52,000 | 351,000 | 45,000 | 900,000 | 1,954,000 |
| SUB-BASIN III | | | | | | |
| MAN-DAYS | 39,000 | 18,000 | 3,000 | *----- | 18,000 | 78,000 |
| POUNDS | 234,000 | 45,000 | 39,000 | *----- | 900,000 | 1,218,000 |
| SUB-BASIN IV | | | | | | |
| MAN-DAYS | 1,063,000 | 490,000 | 497,000 | 50,000 | 98,000 | 2,198,000 |
| POUNDS | 6,378,000 | 980,000 | 6,461,000 | 250,000 | 4,900,000 | 18,969,000 |
| SUB-BASIN V | | | | | | |
| MAN-DAYS | 570,000 | 391,000 | 115,000 | 24,000 | 63,000 | 1,163,000 |
| POUNDS | 3,420,000 | 782,000 | 1,495,000 | 120,000 | 3,150,000 | 8,967,000 |
| SUB-BASIN VI | | | | | | |
| MAN-DAYS | 63,000 | 1,653,000 | 58,000 | 307,000 | 4,000 | 2,085,000 |
| POUNDS | 378,000 | 3,306,000 | 754,000 | 1,535,000 | 200,000 | 6,173,000 |
| SUB-BASIN VII | | | | | | |
| MAN-DAYS | 185,000 | 192,000 | 61,000 | 31,000 | 49,000 | 518,000 |
| POUNDS | 1,110,000 | 384,000 | 793,000 | 155,000 | 2,450,000 | 4,892,000 |
| SUB-BASIN VIII | | | | | | |
| MAN-DAYS | 72,000 | 487,000 | 56,000 | 74,000 | 22,000 | 711,000 |
| POUNDS | 432,000 | 974,000 | 728,000 | 370,000 | 1,100,000 | 3,604,000 |
| SUB-BASIN IX | | | | | | |
| MAN-DAYS | 222,000 | 229,000 | 261,000 | 20,000 | 41,000 | 773,000 |
| POUNDS | 1,332,000 | 458,000 | 3,393,000 | 100,000 | 2,050,000 | 7,333,000 |
| TOTALS | | | | | | |
| MAN-DAYS | 4,045,000 | 4,254,000 | 2,250,000 | 536,000 | 373,000 | 11,458,000 |
| POUNDS | 24,270,000 | 8,517,000 | 29,250,000 | 2,680,000 | 18,650,000 | 83,367,000 |

* NO HABITAT AVAILABLE

Data from unpublished report by Bureau of Sport Fisheries and Wildlife, 1968.

water sport fish are croaker, red drum, sea trout, flounder, tarpon, snappers and groupers.

Freshwater finfishing activity is concentrated in Sub-basin VI which corresponds to the Atchafalaya River basin. Popular freshwater sport fish include largemouth bass, bluegill, redear, crappie and catfish.

Surf-fishing is popular along the barrier islands of coastal Louisiana. However, most of these islands are accessible only by boat. Sport fishing around offshore oil and gas rigs is also popular. Therefore, the large number of man-days spent in sport fishing indicates a corresponding high level of boating activity. It can be assumed that the highest levels of recreational boating related to sport fishing will be found in Sub-basins I and IV where the most sport fishing activity is concentrated. In September, 1970, there were 101,084 registered boats over twelve parishes of Louisiana (Jones and Rice, 1972). This figure includes commercial vessels, but the greatest portion are private recreational boats.

Texas: The Texas Coastal zone, with its immense expanse of shallow bays and beaches accessible to the average man, furnishes an excellent region for the sport fisherman to pursue his avocation. Based upon data generated between 1968 and 1970 the Texas Parks and Wildlife Comprehensive Planning Board ranks fishing as the number one recreation activity in the coastal region of Texas in terms of activity days of participation.

Fishing, with a total of 12,051,800 activity days recorded, was followed by swimming, (4,437,100) boating (3,350,000), camping (3,302,900) and picnicking (2,294,700) (Texas Parks & Wildlife Dept., 1974). Table 21 shows saltwater based activities occurring in the same region but excluding those occurring within urban limits. Fishing again stands out with nearly 6.5 million activity days.

Quantification of saltwater sport fish catch for Texas proved difficult because no comprehensive surveys have been conducted. Creel census data were available for some of the coastal embayments; however, these were not recent and were limited to short time periods (Table 22). Based on existing data from the National Marine Fisheries Service 1970 Saltwater Angling Survey (Deuel, 1973) and an unpublished report from the U. S. Fish and Wildlife Service as well as data from the Texas Parks and Wildlife Department, it was possible to extrapolate and arrive at a gross estimate of the total saltwater sport fish catch as well as an average catch per activity day. It must be stressed that the data available, from the estimates which were made, represent different years, different research procedures and different geographic areas leaving a large margin for error. Even though the margin for error is great, the estimates are felt to be within an acceptable range of probability and represent the best data available.

Table 21. Total Participation in Saltwater Activities Occurring In Rural Areas Within The Gulf Coast Regions (Activity Days)

| Activity | REGION 27 | 25 | 28 | 24 | 33 | 34 | Total |
|---|---|---|---|---|---|---|---|
| Saltwater Boating | 125,258 | 8,914 | 640,644 | 26,480 | 465,408 | 95,821 | 1,362,525 |
| Saltwater Fishing | 220,654 | 296,427 | 2,770,958 | 126,169 | 2,518,885 | 565,357 | 6,498,450 |
| Faltwater Skiing | -0- | 1,740 | 97,921 | 11,538 | 33,592 | 8,048 | 152,839 |
| Surfing | -0- | 3,031 | 206,353 | -0- | 89,053 | 40,184 | 338,621 |
| TOTAL | 345,912 | 310,112 | 3,715,876 | 164,187 | 3,106,938 | 709,410 | 8,352,435 |

Source: Texas Household Demand Survey, 1968, Texas Parks and Wildlife Department, Comprehensive Planning Branch

Table 22 . Listings of General Creel Census Data 1/

| Census Study | Fish Caught/man hr. | Lbs. of Fish Caught/man hr. | Major Species |
|---|---|---|---|
| Lower Laguna Madre Area, 1959-1960 | .99 | 1.15 | Speckled Trout |
| San Antonio Bay Area, Summer, 1962 | .55 | .46 | Not Available |
| Galveston and Trinity Bay Area, 1963-1964 | 1.62 | 1.29 | Sand Trout |
| | | | Croaker |
| | | | Speckled Trout |

1/ Data taken from three different studies. Data was obtained during the summer only in the San Antonio Bay area and catch figures are low as compared to other data due to high participation of tourists.

Source: Creel Census Reports - Texas Parks and Wildlife Department

According to the F&WS report, the total catch for Louisiana was estimated at 24,270,000 pounds, of which 10,986,000 pounds represented the catch east of the Mississippi River, thus leaving an estimated catch for Louisiana west of the Mississippi River of 13,284,000 pounds. The 1970 Angling Survey estimated the total saltwater sport fish catch in the western Gulf at 151,608,000 pounds. By subtracting the F&WS estimate for Louisiana from this total, the new catch for Texas amounted to 138,324,000 pounds. According to the Texas Parks and Wildlife Department's 1968 Household Demand Survey, a total of 6,498,450 activity days were expended in saltwater sport fishing. Using these data, the average catch per activity day was calculated to be 21 pounds for Texas. By combining the F&WS data for Louisiana (man days activity in saltwater sport fishing) and the data for Texas, an average catch per activity day for the western Gulf was calculated at 19 pounds.

Although the sport fishing effort for Texas seems disproportionately high in comparison with Louisiana, when the factor of accessibility to the coastal areas is considered, the reason for the difference becomes more apparent. Much of the Louisiana coast is inaccessible and, because of the isolation, the sport fishing activity is much less than along the Texas coast, most of which is accessible. Additionally, pier fishing is extremely popular along the Texas coast, a type of fishing limited to a few isolated locations along the Louisiana coast. Although sport fishing is an extremely popular recreational activity in coastal Louisiana, offshore saltwater sport fishing is a pursuit enjoyed by a

more affluent group because ownership of a boat is almost a necessity for the Louisiana saltwater sport fisherman.

Data from the 1970 Angling Survey estimated a total of 872,000 sport fisherman were involved in the saltwater sport fishing effort in the Western Gulf. These fishermen caught 151,608,000 pounds, which would give an average yearly catch of 173.86 pounds per fisherman. The number of fish caught was estimated to be 97,708,000 yielding an average weight per fish of 1.55 pounds.

Tables 23 and 24 , from the 1970 Saltwater Angling Survey (Deuel 1973) provide detail of the methods of fishing species of fish caught, their weight and numbers caught in the western Gulf of Mexico.

Big game fishing: Big game fish (also referred to as billfish) are sought in deep water and at considerable distance from shore.

Based on three years of data collection, Luis R. Rivas of the National Marine Fisheries Service made the following comments about the billfish sport fishery of the northern Gulf of Mexico.

During the season (April through October) the fishing effort expended on billfishing amounts to an annual average of 11,756 hours of trolling equivalent to 1,680 boat days. It takes, on the average, 18 fishing days to boat a blue marlin, seven to boat a white, and six to boat a sailfish. Therefore, in 18 days of trolling, it is possible to boat one blue, two whites, and three sails for a total of six billfish, or an average of one fish per three days of trolling. On the average, 657 billfishes weighing a total of 55,782 pounds are caught every year. An average of 103 blue marlin weighing a total of 28,634 pounds are

TABLE 23

NUMBER OF FISH CAUGHT BY SALTWATER ANGLERS IN 1970 IN THE WESTERN GULF OF MEXICO BY SPECIES AND BY PRINCIPAL AREA AND METHOD OF FISHING.
(THOUSANDS)

| Region and species group | Principal Area of Fishing: Ocean | Principal Area of Fishing: Sounds, rivers, and bays | Principal Method of Fishing: Private or rented boat | Principal Method of Fishing: Party or charter boat | Principal Method of Fishing: Bridge pier, or jetty | Principal Method of Fishing: Beach or bank |
|---|---|---|---|---|---|---|
| Basses, Black Sea | -- | 12 | 12 | -- | -- | -- |
| Bluefish | 468 | 9 | 355 | 77 | 12 | 33 |
| Bonitos | -- | 12 | -- | 12 | -- | -- |
| Catfishes | 3,083 | 12,307 | 4,512 | 725 | 7,661 | 2,492 |
| Cobia | 85 | -- | -- | -- | 85 | -- |
| Croakers | 5,476 | 8,417 | 3,384 | 832 | 6,237 | 3,380 |
| Drum, Black | 724 | 4,363 | 4,435 | 16 | 457 | 179 |
| Drum, Red | 2,366 | 3,545 | 4,131 | 47 | 418 | 1,315 |
| Eel, American | -- | 17 | 4 | -- | -- | 13 |
| Flounders, Summer | 984 | 1,192 | 1,714 | 124 | 185 | 153 |
| Groupers | 289 | 149 | 108 | -- | 68 | 262 |
| Grunts | 11,805 | 20 | 11,555 | -- | 270 | -- |
| Jacks | 114 | 31 | 103 | 4 | 12 | 21 |
| Kingfishes | 2,712 | 531 | 541 | 163 | 2,279 | 260 |
| Mackerel, King | 240 | 19 | 123 | 117 | 19 | -- |
| Mackerels, Spanish | 371 | 108 | 218 | 189 | 8 | 64 |
| Mullets | -- | 257 | -- | -- | -- | 257 |
| Perches | 85 | 603 | 40 | 19 | 467 | 162 |
| Pompanos | 111 | 24 | 46 | -- | 89 | -- |
| Porgies | 470 | 1,498 | 1,107 | 163 | 225 | 473 |
| Puffers | 8 | 17 | -- | -- | 25 | -- |
| Sea Robins | 4 | -- | -- | -- | 4 | -- |
| Sea Trout, Sand | 5,282 | 2,907 | 5,645 | 450 | 1,515 | 579 |
| Sea Trout, Spotted | 11,185 | 13,113 | 17,615 | 985 | 2,599 | 3,099 |
| Sharks | 30 | 38 | 30 | -- | 33 | -- |
| Sharks, Dogfish | 10 | 48 | 43 | -- | -- | 15 |
| Skates and Rays | 8 | 263 | 245 | 5 | 12 | 9 |
| Snappers | 1,047 | 168 | 537 | 390 | 288 | -- |
| Snappers, Red | -- | 119 | 119 | -- | -- | -- |
| Spadefish, Atlantic | 91 | 99 | 57 | 19 | 114 | -- |
| Miscellaneous | 125 | 649 | -- | 28 | 149 | 597 |
| Total | 47,173 | 50,535 | 56,684 | 4,425 | 23,236 | 13,363 |

TABLE 24

SALTWATER SPORTFISHING EFFORT IN THE WESTERN GULF OF MEXICO*
BY SPECIES GROUP, NUMBER OF FISH CAUGHT, NUMBER OF ANGLERS,
AND ESTIMATED WEIGHT OF CATCH.

| Species Group | Number of Fish Caught (000) | Number of Anglers (000) | Estimated Weights (000) |
|---|---|---|---|
| Basses | 12 | 4 | 24 |
| Bluefish | 477 | 24 | 1,308 |
| Bonitos | 12 | 6 | 37 |
| Catfishes | 15,390 | 279 | 17,800 |
| Cobia | 85 | 3 | 43 |
| Croakers | 13,893 | 403 | 14,743 |
| Drum, Black | 5,087 | 185 | 13,004 |
| Drum, Red | 5,911 | 302 | 25,520 |
| Eel, American | 17 | 17 | 19 |
| Flounders, Summer | 2,176 | 211 | 2,985 |
| Groupers | 438 | 40 | 922 |
| Grunts | 11,825 | 32 | 4,316 |
| Jacks | 145 | 40 | 1,223 |
| Kingfishes | 3,243 | 90 | 3,107 |
| Mackerels, King | 259 | 39 | 2,978 |
| Mackerels, Spanish | 479 | 31 | 608 |
| Mullets | 257 | 16 | 95 |
| Perches | 688 | 58 | 584 |
| Pompanos | 135 | 45 | 179 |
| Progies | 1,968 | 174 | 5,675 |
| Puffers | 25 | 12 | 8 |
| Sea Robins | 4 | 4 | 1 |
| Sea Trout, Sand | 8,189 | 200 | 9,345 |
| Sea Trout, Spotted | 24,298 | 406 | 40,487 |
| Sharks | 68 | 12 | 1,167 |
| Sharks, Dogfish | 58 | 25 | 54 |
| Skates and Rays | 271 | 29 | 1,603 |
| Snappers | 1,215 | 49 | 2,554 |
| Snappers, Red | 119 | 12 | 278 |
| Spadefish, Atlantic | 190 | 30 | 283 |
| Miscellaneous | 774 | 45 | 658 |
| Total | 97,708 | ** | 151,608 |

* The Western Gulf includes the area between the mouth of the Mississippi River and the Mexican border.

** The number of anglers is not additive because of duplication of anglers among species groups.

caught by anglers every year. On the average, 252 white marlin weighing a total of 13,680 pounds and 302 sailfish weighing a total of 13,288 pounds are caught every year.

In the northern Gulf, the catch-per-unit-of-effort by the sport fishery, for all three species of billfishes combined, was 0.063 fish per hour of trolling in 1971, 0.041 in 1972, and 0.036 in 1973.

Trolling for billfishes is conducted above the continental shelf from about 30 fathoms outward and also above the continental slope at depths of up to 500 fathoms. Distance from shore varies from as little as 12 miles, off the mouth of the Mississippi River, to 60 miles or more off the Clearwater-St. Petersburg area. The most important billfishing ports in the Gulf, from west to east, are Port Isabel, Port Aransas, Rockport and Port O'Connor in Texas; Dauphin Island in Alabama, Golden Meadow and Port Eads in Louisiana; and Pensacola, Destin, Panama City, Clearwater and St. Petersburg in Florida.

The billfish sport fishery was practically nonexistent in the Gulf until about 20 years ago. Pioneered by the New Orleans Big Game Fishing Club, it has grown tremendously since its inception and it still continues to grow.

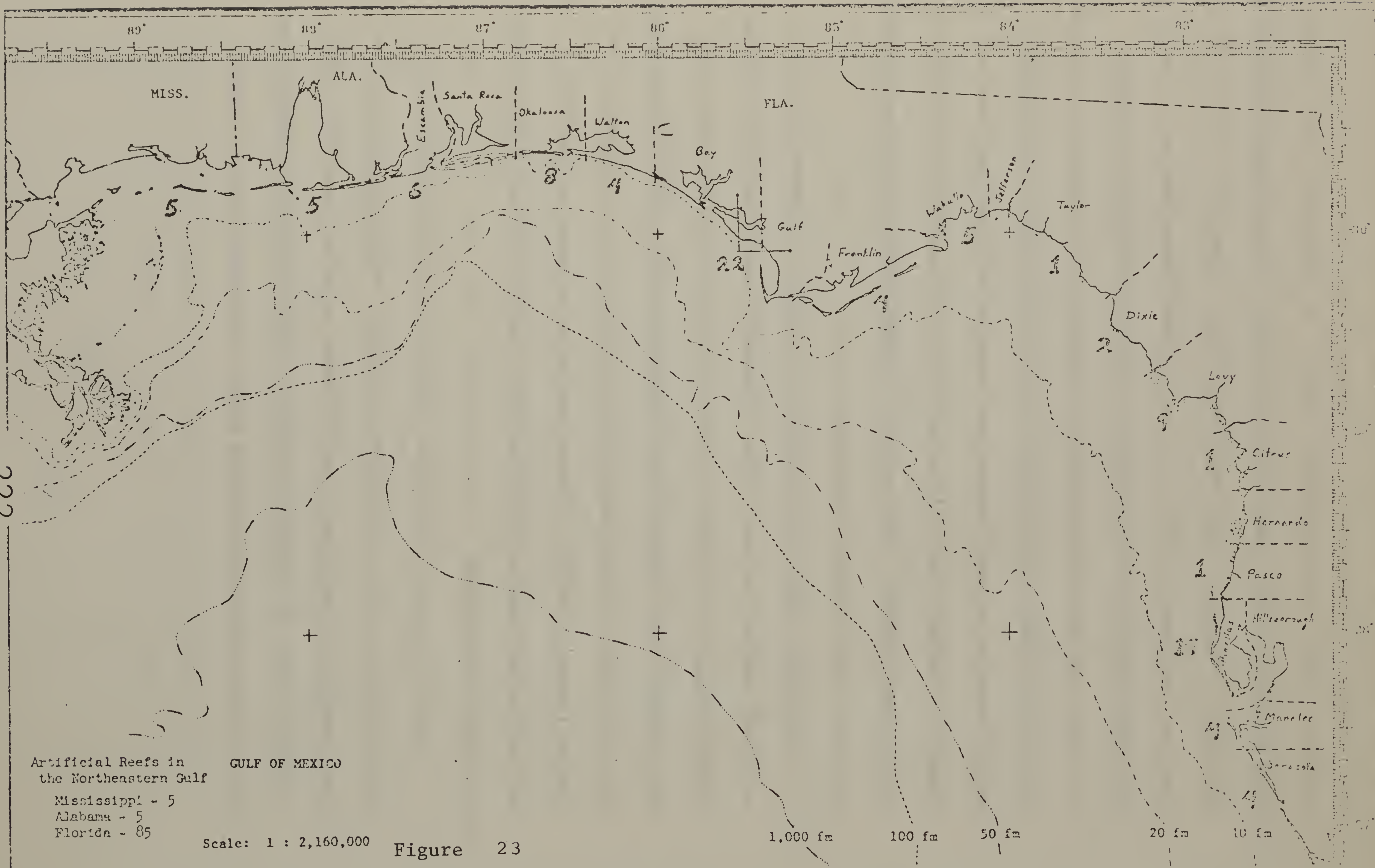
<u>Artificial reefs</u>: In recent years, the establishment of artificial reefs has become popular in the Gulf of Mexico. These artificial reefs, made of old car bodies, tires, concrete pipes, ships, rubble and numerous other materials provide additional surface area of hard substrate on which numerous types of algae and invertebrate species may grow. These organisms are available as food for foraging species,

which in turn, attract predatory fishes. In addition to the expanded food chain and tropic food level potentials, the artificial reefs serve as refuge, protection and orientation sites. These new sites by attracting and concentrating fish species improve fishing success. However, the population size of fish species are not necessarily increased.

There are 95 artificial reefs constructed or in some construction phase within eastern Gulf coastal waters (Figure 23). An undetermined number of private permits are anticipated throughout the region. Except for sunken Liberty Ships the artificial reefs are within the 10 fathom depth contour. The majority of the Florida structures are withing five miles distance from shore.

Additional plans are proceeding to utilize 15 Liberty Ships for artifical reefs. In June, 1975, Mississippi sank the first of five Liberty Ships to be placed in two reef clusters approximately five and fifteen miles south of Horn Island (McIlwain, 1975). Alabama has emplaced three of five planned Liberty Ship reefs in waters off her shores (Swingle, 1975). Florida has a large number of artificial reefs of various materials. In 1973, Bryant reported 85 such reefs off the Gulf Coast of Florida.

The Texas Coastal and Marine Council has plans to acquire 12 Liberty Ships to use as offshore artificial reefs. Four locations have been tentatively selected, each of which could be a site for establishing a reef by sinking of three stripped-down Liberty Ships. The reefs, if established, would be within 30 miles of shore to make




Artificial Reefs in the Northeastern Gulf

Mississippi - 5
Alabama - 5
Florida - 85

Scale: 1 : 2,160,000

Figure 23

them accessible to sport fishermen and divers. However, they will have to be in water at least 80 feet deep in order to allow 50 feet of clearance above the ships which, when stripped, will be about 30 feet high. The site of each reef will be marked by a buoy.

b. Recreational boating

A 1973 National Marine Fisheries Service study provides a general overview of recreational boating in the U.S. and its subdivisions, including the states bordering the Gulf of Mexico. As of October 1973 there were 8,008,000 privately owned recreational fishing boats in the U. S. (Ridgley, 1975) and some 1,010,000 of these boats were used in saltwater recreational fishing activities. It was further estimated that commercial recreation fishing boats in the U.S. numbered 2,496. Table 25 provides more detail data for the Gulf of Mexico Region. In this region 349,000 private recreation boats were used in saltwater. Most of these boats were under 26 feet in length. There were also 473 commercial recreational fishing boats, predominantly in the 40'-65' length class.

The Florida State Outdoor Recreation Plan for 1970 indicates that over 13,287,000 user-occasions of saltwater boating occurred within the Gulf coastal planning regions.

Recreational boating activity is also high in the central Gulf coast area as indicated by saltwater fishing activity. Boats play an important role in recreation in coastal Alabama. In 1969, there were 3,301 private boats 16 feet or longer in the area and it is estimated that $544,665 was spent for gasoline alone to operate

Table 25 Recreational Boating Activity in States Bordering the Gulf of Mexico November, 1972 - October, 1973 (Ridgely, 1975).

| | Less than 16' | 16-26' | Greater than 26' | Total |
|---|---|---|---|---|
| Estimated No. of Private Recreational Boats | 988,000 | 389,000 | 31,000 | 1,408,000 |
| No. of Private Recreational Boats that Fished in Saltwater | 190,000 | 141,000 | 18,000 | 349,000 |
| | **Less than 40'** | **40-65'** | **Greater than 65'** | **All Classes** |
| Estimated No. of Commercial Recreational Fishing Boats | 85 | 310 | 42 | 473 |

| Major Species of Fish Sought By: | Open Ocean | Rivers, Sound, and Bays |
|---|---|---|
| Private Recreational Boaters | Groupers, Red Snappers, Trouts, Snook | Spotted Sea Trout, Red Drum, Snappers |
| Fishermen on Commercial Recreation Boats | Red Snapper, Snappers, Groupers, King Mackerel, Kingfishes | Red, Snapper, Spotted Sea Trout, Sand Sea Trout |

them. In Baldwin County in 1969, there were 34 marinas ( Fig. 24 ) with mooring spaces for 1,137 boats; in Mobile County, 16 marinas with 1,098 mooring spaces. There were 48 public and private boat launching areas in Baldwin County and 18 in Mobile County. An aerial survey made in 1960 showed that there were about 500 fishing piers with an average length of 150 feet along the shores of Mobile Bay. These are used as private boat docks or for fishing. There are three yacht clubs on the bay, two in Mobile County and one in Baldwin County, each with its own fleet of sailboats.

As previously mentioned, in 1970 there were 101,084 boats of all types over 12 feet in length registered in coastal parishes of Louisiana.

In Texas the use of boats for fishing and for a variety of other recreational activities is increasing rapidly. Data compiled by the Texas Parks and Wildlife Department between November 1970 and November 1973 show that total boat registration in the 17 Texas Coastal Counties increased 60.6 per cent (from 73,393 to 121,124). The top ten coastal counties accounted for approximately 28 per cent of all boats registered in Texas during this period.

Population and public access to water seem to be the major factors bearing on boat numbers. Harris County has the largest population and by far the largest number of boats registered in the coastal zone. In general, the counties with high boat registration have access to a large amount of bay and ocean frontage. However, Harris, Orange and San Patricio Counties have no open ocean frontage and relatively little bay frontage, but they do have water

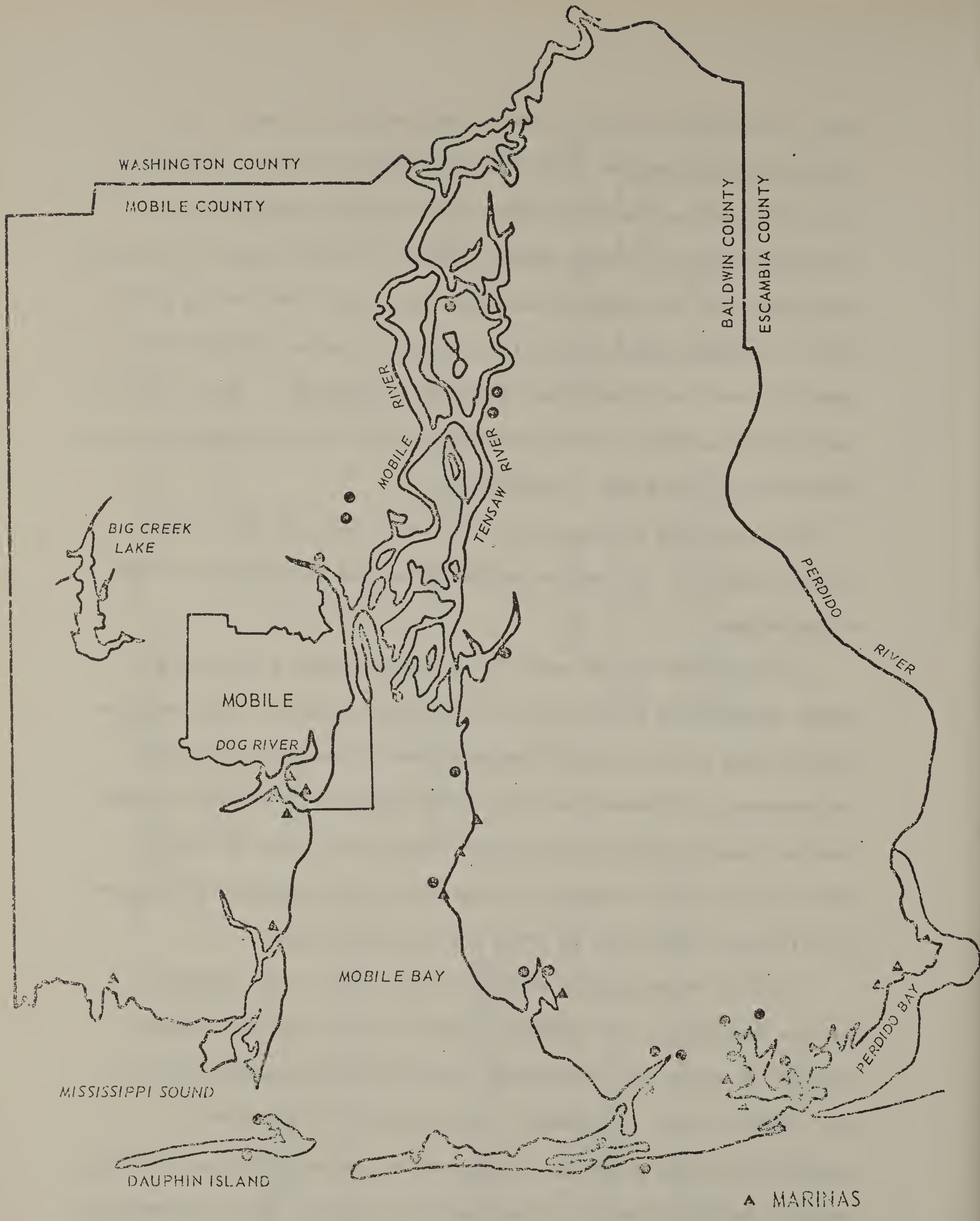



Figure 24 Fishing Camps and Marinas in Coastal Alabama

Source: Chermock, et al. 1954.

access to the ocean and a great deal of fresh water located in or near their boundaries.

The importance of these boats for outdoor recreation is indicated by over 96 percent of those registered in this area in 1973 being classified as "pleasure use" craft.

Top Ten Coastal Counties In Boat Registration
1970 - 1973

| 1970 | | | 1973 | |
|---|---|---|---|---|
| Rank | County | No. of Boats Registered | County | No. of Boats Registered |
| 1 | Harris | 39,819 | Harris | 66,436 |
| 2 | Jefferson | 7,904 | Jefferson | 14,809 |
| 3 | Galveston | 4,935 | Galveston | 7,482 |
| 4 | Nueces | 4,908 | Nueces | 7,158 |
| 5 | Brazoria | 3,699 | Orange | 6,947 |
| 6 | Orange | 3,604 | Brazoria | 6,530 |
| 7 | Cameron | 1.538 | San Patricio | 2,389 |
| 8 | San Patricio | 1,524 | Cameron | 2,261 |
| 9 | Calhoun | 1,191 | Matagorda | 1,559 |
| 10 | Matagorda | 1,075 | Calhoun | 1,476 |
| | TOTAL | 70,197 | TOTAL | 117,047 |

Source: Boat Registration Division, Revenue Branch, Texas Parks and Wildlife Departments.

c. Outdoor recreation areas

Outdoor recreational areas in the western, central and eastern Gulf of Mexico region are illustrated on visual graphics 1, Volume 3.

National parks: The National Park Service administers three major units along the Gulf of Mexico. Everglades National Park at the southern tip of Florida was established in 1947. This subtropical wilderness is a complex of unique plant and animal communities. The everglades habitat contains crocodiles, manatee, roseate spoonbill, reddish egret, wood stork and bald eagle which are rare or unseen elsewhere in the United States. Other important plant and animal inhabitants are the alligator, snook, tarpon, pink shrimp, royal palm, mahogany and mangroves. In fiscal year 1974, Everglades National Park received 990,900 visitors (USDI, 1974j).

Gulf Islands National Seashore was established by Congress in January 1971. This national seashore includes a rather widely spaced chain of offshore islands, extending nearly 150 miles from Ship Island in Mississippi to Santa Rosa Island in Florida, In addition, the seashore incorporates three small mainland tracts: Pensacola Forts and Naval Live Oaks at Pensacola Florida and the Davis Bayou tract in Ocean Springs, Mississippi. In 1975, the Gulf Islands National Seashore received 1,010,700 visits.

The total authorized seashore includes 124,690 acres. Of this, 17,404 acres are fast lands (lands above mean high tide) and the remainder are submerged lands. Of the total of fast lands, about 1,800 acres lie on the mainland; the remaining 15,594 acres lie offshore on the islands. The islands are low, long and narrow, averaging less than a mile in width. Forty-eight-mile-long Santa Rosa is the largest. Horn Island, Mississippi, only 13.6 miles in extent, ranks second in size. Waters adjacent to these lands are also a significant part of the national seashore, and, with the exception of the mainland areas and places where there are closer ship channels, the authorized boundary is one mile off shore.

Ship Island, Mississippi, has regular excursion ferry service from Biloxi and Gulfport, although such service from the latter is only during the summer.

A proposal to establish a wilderness area comprising 1510 acres of Horn and Petit Bois Islands is now under consideration by the National Park Service. Another 2,560 acres are considered potential for later addition to the wilderness area.

Chalmette National Historical Park was the scene of the Battle of New Orleans in the War of 1812. This 142 acre park includes the inactive Chalmette National Cemetery and received 195,000 visits in 1974.

Padre Island National Seashore occupies 132,000 acres of Padre Island extending 80 miles along the south Texas shore from Corpus Christi to near the mouth of the Rio Grande. Besides being one of the last natural seashores in the nation, Padre Island is a wintering area for migratory waterfowl. The island offers numerous recreational activities including swimming, camping, surfing, surf fishing, hiking, birdwatching, beachcombing, scuba diving and sunbathing. In 1974, Padre Island National Seashore received 842,700 visits.

National natural landmarks: The National Park Service administers the National Landmarks program. The objective of this program is to assist in the preservation of natural areas which will illustrate the diversity of the country's natural history. Registration of a site as a Natural Landmark does not change its ownership. However, the owner of the site is required to preserve the natural character of the registered site in order to retain its registration as a Natural Landmark.

Florida has registered nine natural landmarks, eight of which are in or very near Gulf coastal counties. These are:

| | |
|---|---|
| Big Cypress Bend | Collier County |
| Corkscrew Swamp Sanctuary | Collier County |
| Lignumvitae Key | Monroe County |
| Manatee Springs | Levy County |
| Rainbow Springs | Marion County |
| Reed Wilderness Seashore Sanctuary | Marion County |
| Silver Springs | Marion County |
| Wakulla Springs | Wakulla County |

There are as yet no registered national natural landmarks in Louisiana and none in the coastal zone of Texas or Mississippi. In Alabama an important natural landmark was recently registered north of Mobile Bay covering bottomlands for approximately 32 miles along the Mobile and Tensaw Rivers. A major research effort has been sponsored by the National Park Service to identify and evaluate potential natural land landmarks in the Gulf Coastal Plain Physiographic Region of the U. S. The results should be published in 1975.

National wildlife refuges: The U. S. Fish and Wildlife Service of the U. S. Department of the Interior has the responsibility for insuring the conservation of the country's wild birds, mammals and sport fish. The primary purposes of wildlife refuges are to provide sanctuaries for wildlife and fish by preserving breeding grounds and habitat which may be becoming scarce in other areas due to encroachment on natural habitats by agricultural, industrial and urban development, and to provide opportunities for the scientific study of various species of wildlife and for the management and preservation of their populations. These refuges also provide important opportunities for outdoor recreation, primarily nature study and natural scenery appreciation.

Eleven national wildlife refuges are located along Florida's Gulf coast. Three of these areas lie in the Florida Keys outside borders of Visual Graphic No. 1. These are the Key Deer, Great White Heron and Key West National wildlife refuges. They provide protection for the smallest North American deer - the Key deer - and

the great white heron, white-crowned pigeon, reseate spoonbill, Wurdemann's heron, and other wading and shore birds. The Key deer, near extinction in the early 1950's, can now occasionally be seen from the roads on Big Pine and nearby keys. Excellent saltwater fishing is available.

The J. N. "Ding" Darling Refuge, a 4,307-acre area, is situated in the Gulf of Mexico five miles off the coast. A causeway to the island was completed in 1963. To reach this refuge, take State Highway 867, 17 miles southwest from Fort Myers to Sanibel Island. Sanibel Island is famous for the many varieties of shells on its beaches. Beachcombing is a favorite pastime. It is also excellent for swimming, sunbathing, birdwatching and fishing. Also under the refuge manager's supervision are Pinellas, Island Bay and Passage Key National wildlife refuges north of Sanibel. All areas provide important nesting grounds for colonial birds and winter sanctuary for waterfowl.

Chassahowitzka National Wildlife Refuge near Homosassa is managed principally for waterfowl. On this 29,698 acre area sport fishing is permitted as well as managed water fowl hunts in season. Cedar Keys Refuge, a group of four islands comprising 379 acres off the coast of Levy County, is administered by Chassahowitzka Refuge and provides sanctuary and nesting habitat for many colonial birds.

St. Marks National Wildlife Refuge south of Wakulla includes the major Florida wintering area for Canadian geese and is sanctuary for many other waterfowl including nesting bald eagles and ospreys. The refuge is a good example of diversified management including

timber management and several sites of historical interest. Containing 64,074 acres, St. Marks is known for its outstanding birdwatching opportunities and its fresh and saltwater fishing.

St. Vincent National Wildlife Refuge, a 12,445 acre island area accessible only by boat, is located on the Gulf coast between Apalachicola and Port St. Joe. Established in 1968, St. Vincent provides important habitat for many species of migratory birds, resident wildlife and rare and endangered species such as the alligator and bald eagle. Beaches are open year-round for fishing, birdwatching and shelling. Seasonal fishing in fresh water ponds is permitted as well as managed primitive weapon hunts for deer and hogs.

In Jackson County, Mississippi the Sandhill Crane National Wildlife Refuge was established in 1974 for the management of the endangered Mississippi sandhill crane.

The Louisiana coastal zone contains five national wildlife refuges.

The Gulf Islands Refuge consists of Breton and Chandeleur Islands and was established October 1904 and contains 4,507 acres. Many waterfowl and shore birds frequent the islands, and sea turtles nest on their shores. They may be reached only by water and there are no recreational facilities.

The Delta Refuge is on the east bank of the Mississippi River, seven miles below Venice and is accessible only by boat. The refuge contains 48,799 acres. Thousands of blue and snow geese and many species of ducks arrive each fall from the northern breeding grounds

to winter on the Delta marshes. Deer and fur-bearing animals are found in abundance. Alligators are seen frequently but are not abundant. Sport fishing is permitted.

Lacassine National Wildlife Refuge is located in southwest Louisiana. At this 31,766 acre waterfowl wintering area one can see the largest concentration of white-fronted geese in the Mississippi Flyway and one of the larger populations of fulvous tree ducks in the United States. Part of the refuge is open to waterfowl hunting. A main attraction is a 16,000 acre fresh water pool where sport fishing is permitted. Catahoula and Shell Keys National Wildlife Refuges are under the administration of Lacassine Refuge. Catahoula Refuge, established October 1958, contains 5,308 acres. It is situated on the east end of the 26,000 acre Catahoula Lake. Through agreement with the U. S. Army Corps of Engineers and the Louisiana Wild Life and Fisheries Commission, the Bureau manages water levels in the state owned lake. Established primarily as a sanctuary for wintering waterfowl but also for other species of wildlife, fishing and squirrel hunting are permitted. Shell Keys Refuge, established August 1907, is an eight acre colonial bird nesting island offshore in the Gulf of Mexico.

Also in southwest Louisiana is the Sabine National Wildlife Refuge. Established December 1937, this 142,845 acre refuge includes three large artificial freshwater impoundments, and is bounded on the west and east by two large brackish lakes - Sabine and Calcasieu. Sabine provides a winter home for thousands of geese and ducks.

Flocks of blue and snow geese may be seen feeding in the marshes adjacent to the highway. Sport fishing and waterfowl hunting are permitted. The wildlife trail in Pool 1B affords excellent opportunities for visitors in all seasons.

There are five National wildlife refuges on the Texas Gulf coast. The eastern most, Anahuac, occupies 9,940 acres on East Bay of Galveston Bay. The primary species for this refuge are: Lesser Canada, snow and blue geese, mottled ducks, masked ducks, canvasbacks and yellow rails. Rare and endangered species are alligators, bald eagles and peregrine falcons.

Brazoria National Wildlife Refuge contains 9,530 acres of coastal marsh and prairies in Brazoria County. Three-fourths of the refuge is less than four feet in elevation, and spoil bank knolls and windbreak plantings are the only break in the marsh vegetation. The primary species of this refuge are: geese, ducks and muskrats and endangered species include alligators and red wolves. The refuge offers public hunting and fishing in limited areas, sightseeing, birdwatching and nature photography. The refuge office, which also administers the San Bernard National Wildlife Refuge, is located in Angleton, Texas.

San Bernard National Wildlife Refuge, which was established in November of 1968, is Texas' newest wildlife refuge containing 14,920 acres in Brazoria and Matagorda counties. The primary species for this refuge are: geese, ducks, wading birds, shorebirds and the endangered red wolf.

The Aransas National Wildlife Refuge occupies 54,830 acres in Calhoun, Aransas and Refugio counties and is the largest on the Texas coast. This refuge is the wintering ground for the rare and endangered whooping crane. Other primary species include: sandhill cranes, roseate spoonbills, egrets, herons, peregrine falcons, geese, ducks, turkeys, shorebirds, deer, peccaries, caracaras, white-tailed hawks, Texas red wolves and alligators.

Texas' second largest wildlife refuge, Laguna Atascosa National Wildlife Refuge, occupies 45,150 acres in Cameron County. Located twenty-five miles northeast of San Benito, this refuge was established in March of 1946 to serve as a wintering and feeding ground for migrating ducks and geese. The primary species for Laguna Atascosa National Wildlife Refuge are: geese, ducks, herons, ibises, shorebirds, gulls, terns, doves, cranes, white-tailed hawks and white-tailed kites. The refuge offers a variety of habitat including coastal prairies, salt flats and low wooded ridges. Subtropical forms, such as the ocelot and the jaguarundi, occur along with species from the northern latitudes. Tour roads, hiking trails, and blinds are provided for visitors to use in sightseeing, nature study and photography. Camping is permitted in designated areas, and saltwater fishing and boating are allowed in the Intracoastal Canal. A major portion of the Laguna Atascosa National Wildlife

Refuge has been recommended for National Landmark recognition.[1/]

State wildlife refuges and management areas: All Gulf states maintain wildlife management areas within the coastal zone. Their locations and approximate size can be determined from Visual Graphic No. 1 for each of the three Gulf divisions as contained in Vol. II of this statement.

Although management goals may differ somewhat from state to state, these areas serve primarily to maintain habitat and breeding space for wildlife, and to provide wildlife-oriented recreation under closely controlled conditions.

There are 18 state wildlife management areas in Gulf coastal Florida and three of these are made up of multiple units. Several state forests are found near the Gulf coast with state wildlife management areas overlapping or coincident to their boundaries. State wildlife management status also applies within the Apalachicola National Forest in the Florida panhandle.

Alabama has only one state wildlife management area in a coastal county. This is the 24,000 acre Rob Boykin area and because it is located in extreme northern Mobile County it could not be portrayed on Visual Graphic No. 1.

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1/ For a more detailed discussion of Texas National Wildlife Refuges see Department of the Interior, 1974, Final Environmental Statement, Vol. 1, OCS Sale No. 37, FES 74-63, pps. 335-340.

Mississippi has two wildlife management areas near the coast, although none are on salt water.

The Louisiana Wildlife and Fisheries Commission administers three wildlife refuges in the coastal area. These are the Russell Sage or Marsh Island Refuge (79,000 acres) at the mouth of Vermilion Bay, the nearby Louisiana State Refuge (15,000 acres) and the Rockefeller Refuge (82,000 acres). In addition there are 12 state wildlife management areas or preserves.

The Texas Parks and Wildlife Department administers three state-owned wildlife management areas. They range from 8,403 to 502 acres in size. The smallest Las Palomas Wildlife Management area in extreme Texas is divided into three separate small units.

Private wildlife refuges: The National Audubon Society manages the 26,161 acre Paul J. Rainey Wildlife Refuge on the Louisiana coast as well as several tracts in the Texas coastal zone. Some of these are located near state or national wildlife refuges and serve to extend the sanctuary provided by there refuges.

Table 26. State Wildlife Management Areas and Preserves

Florida

| Name of Area | County Location | Acreage |
|---|---|---|
| C. M. Webb | Charlotte | 62,500 |

(continued)

Table 26 (continued)

| Name of Area | County Location | Acreage |
|---|---|---|
| Hillsborough | Hillsborough | 15,700 |
| Richloam | Pasco and Hernando | 26,000 |
| Croom | Hernando and Sumter | 17,000 |
| Citrus | Citrus and Hernando | 42,330 |
| Gulf Hammock | Levy | 120,000 |
| Steinhatchee | Dixie | 220,000 |
| Tide Swamp | Taylor | 20,543 |
| Aucilla | Taylor, Jefferson and Wakulla | 184,950 |
| Apalachicola | Wakulla and Franklin | 166,526 |
| Ed Ball | Gulf | 66,432 |
| G. U. Parker | Gulf | 6,900 |
| Gaskin | Gulf and Bay | 40,157 |
| Point Washington | Bay and Walton | 186,000 |
| Eglin Air Force Base | Walton, Okaloosa and Santa Rosa | 461,117 |
| Blackwater River | Escambia | 183,112 |
| St. Regis | Escambia | 20,000 |
| La Floresta Perdida | Escambia | 30,100 |
| Alabama | | |
| Rob Boykin | Mobile | 24,000 |
| Mississippi | | |
| Red Creek | Harrison, Jackson, Stone and George | N/A |
| Wolf River | Pearl River | |

(continued)

Table 26 (continued)

| Name of Area | County Location | Acreage |
|---|---|---|
| Louisiana | | |
| Pearl River | St. Tammany (Parish) | 26,716 |
| St. Tammany | St. Tammany | 1,300 |
| Biloxi | St. Bernard | 39,583 |
| Bohemia | Plaquemines | 33,000 |
| Pass a Loutre | Plaquemines | 66,000 |
| Wisner | Lafourche | 21,621 |
| Salvador | St. Charles | 27,499 |
| Pointe au Chien | Lafourche | 28,244 |
| Bonnet Carre' | St. Charles | 3,789 |
| Thistlethwaite | St. Landry | 11,100 |
| West Bay | Allen | 55,185 |
| Sabine | Calcasieu | 10,500 |
| Texas | | |
| J. D. Murphee | Jefferson | 8,403 |
| Sheldon | Harris | 2,503 |
| Las Palomas | | 669 |
| Longoria Unit | Cameron | |
| Voshell Unit | Cameron | |
| Fredricks Unit | Willacy | |

Source: Florida Department of Transportation: County maps showing areas of environmental concern.

Table 27 identifies the Audubon sanctuaries in Texas. They are located on Visual Graphic No. 1 for the western Gulf.

Table 27 National Audubon Society Sanctuaries in Texas

| Name of Area | Acres |
|---|---|
| Vingt-et-un Islands of Galveston, Turtle and East bays | 40 |
| Matagorda Island on Wynns Ranch across from Aransas National Wildlife Refuge in Mesquite, Ayres and San Antonio bays | 5,720 |
| Green Island and Three Island Tracts in Laguna Madre | 450 |
| Birds Island and North Deer Island in Chocolate and West Bay and the southwest part of Galveston Bay | 100 |
| Lydia Ann Island, portions of Harbor Island and small tracts in Copano, St. Charles, Aransas, and Red Fish bays | 750 |
| Tract portions of the second chain of islands in San Antonio Bay | 80 |
| | 7,140 |

Source: Texas Parks and Wildlife Department

Aquatic Preserves: The aquatic preserves system is unique to Florida. Florida owns, by virtue of its sovereignty, some 10,000 square miles of submerged tidal lands offshore from its extensive Atlantic and Gulf coastlines and in its numerous bays, estuaries and lagoons. Much of this submerged land supports biological, aesthetic and other natural features important ecologically and for outdoor recreation, but all of it is potentially vulnerable to major impairment from incompatible development. To set aside certain exceptionally valuable and representative areas for perpetual public enjoyment and to preserve important natural systems, a state-wide system of aquatic preserves was established by formal dedication of the sovereignty lands involved. The subsequent management program for the

preserves emphasized protection of the existing natural values as well as promotion of compatible outdoor recreational uses, such as boating, fishing,skin diving and sightseeing. The State of Florida Board of Trustees of the Internal Improvement Trust Fund has management responsibility at present.

State parks: State parks average much smaller in size that the wildlife areas previously discussed and are generally more activity oriented than the national parks. They are numerous and widely distributed along the Gulf coast and serve a large number of people within their localities as well as significant numbers of regional and national visitors. Sixty-five state parks, monuments, memorials and recreation areas covering more than 92,000 acres were identified along the Gulf coast. They ranged in size from the 28,876 acre Myakka River State Park in Florida to the one acre Port Isabel Lighthouse State Historic site in Texas.

Collectively the state parks constitute a major part of the recreational resources of the region. Their number and diversity makes generalization difficult. Not only do they vary in size, but their activity and resource orientation varies from fishing causeways through intensively developed recreation sites to scientific, cultural and aesthetic themes.

Table 28 lists these parks by state. They may be located on Visual Graphics No. 1 (Vol. 3). For a more detailed discussion of the State Parks in the western Gulf see Department of the Interior

Table 28 State Parks in the Gulf Coastal Area

Florida Gulf Coast State Parks

| Name | Acreage | Name | Acreage |
|---|---|---|---|
| Collier-Seminole | 6423 | Lake Rousseau | 4,867 |
| Wiggins Pass | 166 | Manatee Springs | 1,799 |
| Mound Key | 149 | Forest Capitol | 14 |
| Koreshan | 156 | Ochlockonee River | 392 |
| Caloosahatchee River | 718 | St. George Island | 318 |
| Port Charlotte Beach | 245 | St. Joseph | 2,516 |
| Oscar Scherer | 462 | St. Andrews Bay | 1,063 |
| Myakka River | 28,876 | Grayton Beach | 356 |
| Lake Manatee | 556 | Basin Bayou | 287 |
| Hillsborough River | 2,848 | Ponce de Leon | 120 |
| Anclote Key | 195 | Fred Gannon | 632 |
| Caladesi Island | 1,712 | John Beasley | 23 |
| Fort Cooper | 708 | Blackwater River | 360 |

Total Acreage 55,970

Alabama State Parks

| | | | |
|---|---|---|---|
| Meaher | 300 | Fort Gaines | 10 |
| Fort Morgan | 310 | USS Alabama Rec. Area | 32 |
| Gulf State Park | 5,687 | Bear Point Park | 4 |
| Romar Beach | 5 | Casino, Dauphin Island | 528 |
| Alabama Point Wayside Park | 25 | | |

Total Acreage 7,001

Mississippi State Parks

| | |
|---|---|
| Fisherman's Wharf | N/A |
| Magnolia | N/A |
| Buccaneer | N/A |

(continued)

Table 28 (continued)

Louisiana State Parks

| Name | Acreage | Name | Acreage |
|---|---|---|---|
| Fort Macomb | 16 | Edward Douglas White State Monument | 6 |
| Fort Pike State Monument | 125 | Fairview Riverside | 99 |
| Longfellow-Evangeline | 157 | Nibletts Bluff Confederate Memorial | 32 |
| Bogue Falaya Wayside Park | 13 | Grand Isle | 140 |
| Fontainebleau | 2,755 | Cypremort Beach | 185 |
| Sam Houston | 1,068 | Rutherford Beach | N/A |
| St. Bernard | 358 | | |

Total Acreage 4,954*

* excluding Rutherford Beach

Texas State Parks

| | | | |
|---|---|---|---|
| Sea Rim State Scenic Area | 16,048 | Sabine Pass Battleground State Park (undeveloped) | 56 |
| San Jacinto Battlefield State Historic Park | 445 | Galveston Island State Recreation Park (undeveloped) | 1,921 |
| Varner-Hogg Plantation State Historic Park | 66 | Bryan Beach State Park (undeveloped) | 554 |
| Mud Island State Recreation Park (undeveloped) | 1,075 | Port Lavaca Causeway State Recreation Park | 2 |
| Goose Island State Recreation Park | 307 | Copano Bay Causeway State Park | 6 |
| Mustang Island State Recreation Park (undeveloped) | 3,570 | Lipanitlan State Park | 5 |
| Brazos Island State Scienic Park | 216 | Port Isabel Lighthouse State Historic Site | 1 |

Total Acreage 24,272

| | Areas | Total Acreage |
|---|---|---|
| Florida | 26 | 55,970 |
| Alabama | 9 | 7,001 |
| Mississippi | 3 | N/A * |
| Louisiana | 13 | 4,954 |
| Texas | 14 | 24,272 |
| | 65 | 92,197* |

Local outdoor recreation facilities: In addition to Federal and State recreation areas, there are numerous city and county parks and recreation areas in the coastal zone. These facilities are generally located in and around the major population centers where the demand is greatest. In addition private and commercial recreation facilities exist in great numbers. The list could include marinas, tennis clubs, amusement parks and many others. In the Gulf coastal counties of Florida alone;local outdoor recreation sites number approximately 441 including city, county and private facilities (Fla. Dept. Transportation). Due to their large number, small size, and difficulty in obtaining comparable data for the entire Gulf area a complete mapping of these facilities was not attempted. This should not be construed as detracting from their importance in providing the bulk of day-to-day outdoor recreation opportunities for Gulf coast residents.

Recreation beaches: Wherever they are accessible for recreational use the sandy beaches along the Gulf of Mexico are of major recreational importance. These beaches are also potentially vulnerable to offshore oil spills and to direct visual impact from any near-shore structures or lease generated traffic.

A detailed inventory of Gulf of Mexico shoreline conditions is provided by the U. S. Army Corps of Engineers National Shore Line Study Regional Reports, 1971.

Table 29 gives selected shoreline data for the Gulf of Mexico. The tabulation for Florida covers all Gulf-facing counties beginning with Monroe, and thus includes a few miles of Atlantic shore on the outer side of the Keys. Approximately 2100 miles of shore face the Gulf of Mexico, 1200 miles of which are sand beaches and 900 miles non-beach shore , usually marsh or mangrove. Bay and estuarine shoreline is much greater, totaling about 7100 miles,with a much lower ratio of beach to non-beach shoreline. Public ownership of the total shoreline is about twenty percent and approximately the same percentage is used for recreation, public and private.

There is a higher recreational use of shores facing the open Gulf where public and private recreation accounts for about thirty percent of the shoreline.

Sand beaches are identified on Visual Graphic No. 1 for each of the three northern Gulf of Mexico zones (Volume 3).

The entire Gulf of Mexico shore of Florida from Key West north to Apalachee Bay is characteristically a mangrove swamp or marsh, with sandy beach areas occurring from place to place. Most of the Gulf shore from the southern tip of the state northward to Anclote Key on the Pinellas-Pasco County line is composed of offshore barrier islands. These offshore barrier islands begin with the Ten Thousand Islands at the south and extend northerly almost continuously for more than 150 miles. The shore, particularly in the southerly part of the region, is a very intricate network of tidal creeks and scattered mangrove

Table 29 Gulf of Mexico
Selected Shoreline Information

| Location | Physical Characteristics | | | Shore Ownership | | | Shore Use | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Shore Length | Beach Length | Non-Beach Shore | Federal | Non-Federal Public | Private | Public Recreation | Private Recreation | Non-Recreational Development | Undeveloped |
| | | | | Data In Miles | | | | | | |
| A. Gulf Shoreline | | | | | | | | | | |
| Florida | 840.1 | 403.3 | 436.8 | 111.9 | 97.3 | 569.1 | 100.3 | 187.4 | 83.6 | 465.7 |
| Alabama | 46.4 | 46.4 | 0 | .4 | 4.8 | 41.2 | 4.0 | 30.3 | 2.0 | 10.1 |
| Mississippi | 33.2 | 27.0 | 6.2 | 15.3 | 0.6 | 17.3 | 0 | 6.9 | 0 | 26.3 |
| Louisiana | 810.0 | 365.0 | 445.0 | 160.1 | 181.9 | 468.0 | 7.5 | 2.1 | 7.2 | 793.2 |
| Texas | 373.0 | 361.0 | 12.0 | 96.0 | 12.0 | 265.0 | 270.0 | 41.0 | 0 | 62.0 |
| Sub-total | 2,102.7 | 1,202.7 | 900.0 | 383.7 | 296.6 | 1,360.6 | 381.8 | 267.7 | 92.8 | 1,357.3 |
| B. Bay and Estuary Shore | | | | | | | | | | |
| Florida | 3,324.2 | 507.3 | 2,753.9 | 418.0 | 79.2 | 2,764.8 | 65.6 | 470.1 | 735.0 | 2,075.8 |
| Alabama | 305.3 | 180.6 | 124.7 | 1.9 | 7.9 | 295.5 | 27.6 | 179.6 | 3.0 | 95.1 |
| Mississippi | 213.8 | 69.8 | 144.0 | 17.9 | 41.9 | 154.0 | 31.0 | 99.0 | 9.5 | 74.3 |
| Louisiana | 1,133.0 | 470.0 | 663.0 | 85.4 | 150.0 | 897.6 | 10.3 | 26.1 | 39.1 | 1,057.5 |
| Texas | 2,125.0 | 16.0 | 2,109.0 | 292.0 | 43.0 | 1,790.0 | 116.0 | 119.0 | 107.0 | 1,783.0 |
| Sub-total | 7,101.3 | 1,243.7 | 5,794.6 | 815.2 | 322.0 | 5,901.9 | 250.5 | 893.8 | 893.6 | 5,085.7 |
| Total Shoreline | 9,204.0 | 2,446.4 | 6,694.6 | 1,198.9 | 618.6 | 7,262.5 | 632.3 | 1,161.5 | 986.4 | 6,443.0 |

Source: Department of Army: Corps of Engineers, 1971b

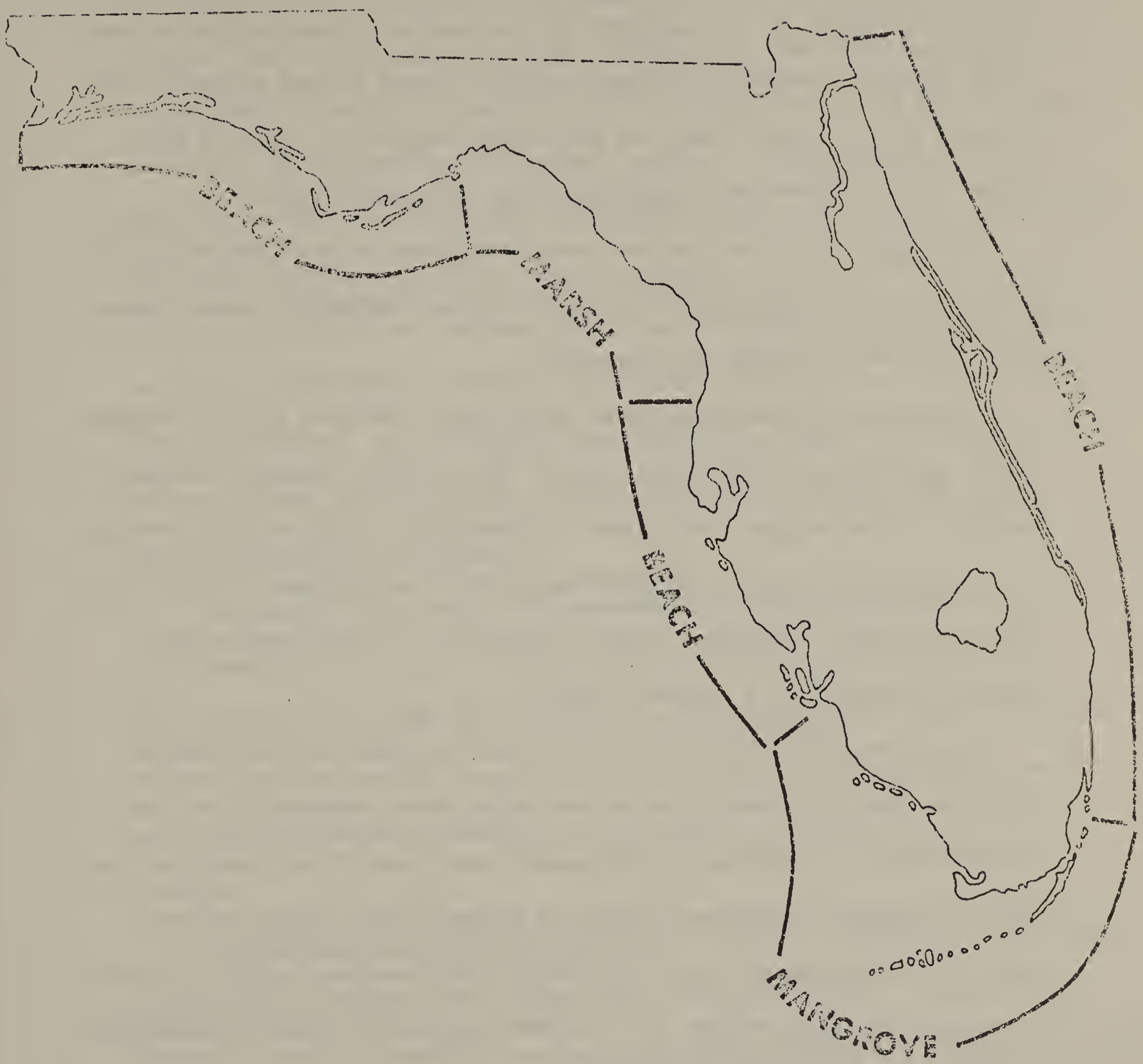
swamps. The offshore barrier islands or keys are separated from the mainland by generally shallow tidal lagoons and from each other by shallow natural passes. Many of those passes have been improved for navigation purposes. The beaches in this lower region, where they exist, are composed of fine white sand and contain a considerable amount of shell.

The Gulf coast of Florida from Anclote Key to Apalachee Bay, a distance of some 180 miles, is almost devoid of barrier beaches. Between those points the shore consists almost entirely of low, flat, salt marshes. The water off the coast in this region is very shallow for a considerable distance gulfward. The coast west of Ochlockonee Bay located at the west end of Apalachee Bay is characterized by wide sandy beaches, backed by dune lines with heights ranging from ten to fifteen feet. Most of the beach material along this reach is white sand composed primarily of quartz. From the Cape San Blas and St. Joseph Spit area the shoreline extends in a long arc to the Alabama state line.

Figure 25 generalizes the Florida shoreline in terms of beach, marsh or mangrove dominance.

In Florida, title to riparian property generally extends to the mean or ordinary high-water line. Seaward of that line the beach and submerged bottom lands are the property of the State. Such lands are in the custody of the Trustees of the Internal Improvement Fund, a State body, to be held in trust for the benefit of the people

Figure 25. GENERALIZED SHORELINE TYPES IN FLORIDA




Source: Florida Department of Natural Resources
Outdoor Recreation in Florida, 1971

of the State. The public may not be deprived of the right of access to the beach below highwater except by such lawful regulation as may be imposed in the interest of the public. Unrestricted access to the beach is available through publicly owned upland property such as beach parks, street ends and shorefront highways. Most of the upland shores (above mean highwater) are privately owned.

The most intensive recreational development along Florida's Gulf coast is in the Tampa Bay vicinity and in the Panhandle around Panama City, Fort Walton Beach and Pensacola.

Alabama and Mississippi have short Gulf frontages but the beaches are of good quality and heavily used. The barrier islands from west Florida to Mississippi are fringed by especially high quality beaches. This was a major factor contributing to the establishment of the Gulf Islands National Seashore. Twenty-seven miles of the Mississippi mainland frontage is a man-made beach.

Louisiana has very limited beach area suitable for recreation. The three areas in coastal Louisiana which have experienced the most beach-oriented recreational development are Grand Isle, Vermilion Bay, and the southwest Louisiana coastline between Holly Beach and the mouth of the Mermentau River. Although there are many miles of beach shoreline, a large portion of it is very narrow, of poor recreational quality and generally inaccessible.

A detailed discussion of central Gulf beaches may be found in Final Environmental Statement, OCS Sale No. 38, FES 75-37 Vol. 1, pp 233-236.

The Texas coast has 373 miles of shoreline facing the Gulf of which 361 miles is beach shore. The much more extensive Bay and estuarine shore has very little beach area. An estimated 270 miles of Gulf beach are used for public recreation. The mainland shore is paralleled by barrier islands except at Sabine Pass, the Brazos River delta and the entrances to bays and lagoons. These barrier islands range in width from a few hundred yards to three miles and are separated from the mainland by shallow coastal lagoons, three to five miles wide. This double shoreline combined with the sub-tropical climate and gentle terrain of the region provides conditions favorable for year-round outdoor recreation. As previously mentioned, the Padre Island National Seashore faces the Gulf with about eighty miles of excellent beach from Corpus Christi southward.

The Texas "open beach law" passed by the Texas Legislature in 1959 provides for public access and use of the beaches having open Gulf exposure from the mean low tide to the vegetation line. Not all beaches are physically accessible for recreation use and there remain some legal questions relating to full public utilization of Texas beaches.

Miscellaneous recreation resources: Several additional significant recreational resources are found along the Gulf coast. Louisiana and Alabama contain ornamental gardens, and scenic roads and rivers have been designated in Louisiana and Texas. Florida has designated a number of wild and scenic rivers as well as a system of canoe trails. Louisiana has just completed a statewide trails development plan indicating a widespread interest in hiking and biking facilities.

d. Historical resources

The National Register of Historic Places was the major source consulted for historical sites. (Federal Register, 1975). The State Historical Preservation Officer for each Gulf state was contacted to determine if any historical or archaeological sites potentially eligible for the National Register are located in the Gulf OCS area. None are known at the present time within the area to be effected by this sale.

The National Register historic sites and the number of recorded archaeological sites in each Gulf coastal county are shown on visual graphic 5, Volume 3.

Tables 30 through 32 lists the National Register sites which may be located by number on these graphics.

Table 30. National Register of Historic Places Sites plotted on eastern Gulf of Mexico Visual Graphic No. 1

Florida

Pensacola

1. Lavalle House
2. Pensacola Historic District
3. Plaza Ferdinand VII
4. Old Christ Church
5. St. Michael's Creole Benevolent Association Hall
6. Buccaneer (Schooner)
7. Clara Barkley Dorr House
8. Fort George Site
9. Fort San Carlos de Barrancas
10. L & N Marine Terminal Bldg.
11. Pensacola Lighthouse and Keeper's Quarters
12. Fort Pickens

(continued)

Table 30 (continued)

13. Fort Walton Mound
14. Chautauqua Auditorium
15. David G. Raney House
16. Trinity Episcopal Church
17. Pierce Site
18. Cape St. George Light
19. Fort Gadsden Historic Memorial
20. Yent Mound
21. Porter's Bar Site
22. Bird Hammock
23. St. Marks Lighthouse
24. Fort San Marcos de Apalache
25. San Juan de Aspalaga Site
26. San Joseph de Ocuya Site
27. Lloyd Railroad Depot
28. Asa May House
29. San Miguel de Asile Mission Site
30. Perkins Opera House
31. Wirick - Simmons House
32. Lyndhurst Plantation
33. Crystal River Indian Mounds
34. Yulee Sugar Mill Ruins
35. Fort Cooper
36. Safety Harbor Site
37. Andrews Memorial Chapel
38. Tarpon Springs Sponge Exchange
39. Safford House
40. Weeden (Weedon) Island Site

Tampa

41. Circulo Cubano de Tampa (Cuban Club)
42. El Pasaje (Cherokee Club)
43. Tampa Bay Hotel
44. Ybor Factory Building
45. Ybor City Historic District
46. Chapin House
47. Centro Asturiano
48. El Centro Espanol of W.Tampa
49. Federal Building, U. S. Courthouse, Downtown Postal Station
50. House at 1415 N. Franklin St.
51. Johnson-Wolff House
52. Leiman House
53. Levick House
54. Old School House, Lafayette St.
55. Stovall House
56. T. C. Taliaferro House
57. Tampa City Hall
58. Union Railroad Station

59. Fort Foster
60. George McA. Miller House
61. Cockroach Key
62. De Soto National Memorial
63. Madira Bickel Mound
64. Robert Gamble House (Judah P. Benjamin Memorial)
65. Demere Key
66. Pineland Site
67. Sanibel Lighthouse and Keeper's Quarters
68. Mound Key
69. Seaboard Coastline Railroad Depot
70. Ted Smallwood Store (Chokoloskee Is.)

Alabama

71. Indiana Mound Park
72. Fort Morgan
73. Middle Bay Light

Mobile

74. Barton Academy
75. Bishop Portier House
76. Bragg-Mitchell House

(continued)

Table 30 (continued)

77. Brisk and Jacobson Store
78. Carolina Hall
79. Church Street East Historic District
80. City Hall
81. De Tonti Square Historic District
82. Fort Conde-Charlotte Site
83. Gates-Davis House
84. Georgia Cottage
85. Martin Horst House
86. Kirkbride House
87. Oakleigh
88. Oakleigh Garden Historic District
89. Old City Hospital
90. Protestant Children's Home
91. Raphael Semmes Home
92. Spring Hill College Quandrangle
93. U. S. Marine Hospital

Table 31 National Register of Historic Places and Other Historic Sites Plotted on Central Gulf of Mexico Visual Graphic No. 1

Louisiana

1. Joseph Jefferson House
2. Acadian House
3. U. S. Post Office St. Martinville
4. St. Martin of Tours Catholic Church
5. Shadows-on-the-Teche Plantation
6. Sacred Heart Academy
7. Parlange Plantation House
8. Live Oaks Plantation
9. Bayou Plaquemines Lock
10. St. Gabriel Roman Catholic Church
11. The Hermitage
12. Oak Allen Plantation
13. San Francisco Plantation House
14. Southdown Plantation
15. Home Place Plantation
16. Destrehan Plantation
17. Grace Memorial Episcopal Church

New Orleans Sites

18. Bank of Louisiana
19. Big Oak-Little Oak Islands
20. The Cabildo
21. George Washington Cable House
22. French Market - Old Meat Market
23. French Market - Old Vegetable Market
24. Gallier House
25. The Garden District
26. General Laundry Building
27. Nicholas Girod House
28. Hermann-Grima House
29. Jackson Square
30. Lafayette Cemetery No. 1
31. Lafitte's Blacksmith Shop
32. Lower Garden District
33. Madame John's Legacy
34. Merieult House
35. Old Ursuline Convent
36. Old U. S. Mint, New Orleans
37. Perseverance Hall
38. Pilot House (Ducayet House)
39. The Presbytere
40. Jean Louis Rabassa (McDonogh No. 18 School Annex)
41. St. Alphonsus Roman Catholic Church
42. St. Charles Streetcar Line

(continued)

Table 31 (continued)

43. St. Mary's Assumption Church
44. Turpin-Kofler-Buja House
45. U. S. Court of Appeals - Fifth Circuit
46. U. S. Custom House
47. Vieux Carre Historic District
48. James H. Dillard House
49. Faubourg Marigny
50. St. Patrick's Church

51. Fort Pike (Also State Monument)
52. Ft. de la Boulaye
53. Ft. Jackson
54. Ft. St. Philip

Mississippi

55. Jackson Landing Site
56. Beauvoir (Jefferson Davis Home)

Biloxi Sites

57. Biloxi Garden Center (Old Brick House)
58. Biloxi Lighthouse
59. Gillis House
60. Magnolia Hotel
61. Margaret Emilie (Schooner)
62. Milner House (Grass Lawn)

63. Fort Massachusetts
64. Louisville and Nashville Railroad Depot
65. U. S. S. Cairo

Alabama

66. Indian Mound Park - Dauphin Island

Mobile Sites

67. Barton Academy
68. Bishop Portier House
69. Bragg-Mitchell House
70. Brisk and Jacobson Store
71. Carolina Hall (Yesterhouse, Dawson-Purdue House)
72. Church Street East Historic District
73. City Hall
74. De Tonti Square Historic District
75. Fort Conde-Charlotte Site
76. Gates-Davis House
77. Georgia Cottage
78. Martin Horst House
79. Kirkbride House (Fort Conde-Charlotte House)
80. Oakleigh
81. Oakleigh Garden Historic District (Washington Square)
82. Old City Hospital
83. Protestant Children's Home
84. Raphael Semmes Home
85. Spring Hill College Quandrangle
86. U. S. Marine Hospital

(continued)

Table 31 (continued)

87. Middle Bay Light
88. Fort Morgan

(Additional National Register sites in the Alabama Coastal Zone but lying beyond the map border are:)

Blakely - N. of Bridgehead
Battle Creek Indian Mounds - W. of Stockton
Fort Mims Site - Tensaw Vicinity
Seaboard Bluff (Nanna Hubba Bluff) - NW of Stockton
Ellicot Stone - N. of Mobile

Other Central Gulf Historic Sites

89. Evangeline Oak
90. Darby Plantation
91. Albania Historic Site
92. Oaklawn Manor
93. Munell House
94. Indian Mounds
95. Ellendale Plantation
96. Indian Mounds
97. Indian Mounds
98. Ft. Livingston
99. Poverty Point
100. Ft. Maurepas
101. Old Indian Springs
102. Graveline Mounds
103. Old Spanish Fort
104. Fort Gaines
105. U. S. Alabama Memorial Park

Table 32 National Register of Historic Places and Other Historic and Recreational Sites Plotted on Western Gulf of Mexico Visual Graphic No. 1

Texas

1. Fort Brown
2. Resaca de la Palma Battlefield
3. Palo Alto Battlefield
4. Brazos Santiago Depot
5. Garcia Pasture Site
6. Mansfield Cut Underwater Archaeology Dist.
7. King Ranch (Extends through Nueces, Kleberg, Kenedy, and Willacy Counties)
8. Dunn Ranch, Novillo Line Camp
9. James McGloin Homestead
10. Thomas H. Mathis House

Galveston

11. Ashbel Smith Building (Old Red)
12. Ashton Villa
13. Bishop's Place (Gresham House)
14. Grand Opera House
15. St. Mary's Cathedral
16. George Sealy House
17. The Strand Historic District
18. Trueheart-Adriance Building
19. U. S. Custom House (Old Galveston Custom House)
20. Samuel May Williams House

Houston

21. 1884 Houston Cotton Exchange Building
22. Pillot Building
23. Sweeny, Coombs, and Fredericks Building
24. U. S. Custom House
25. San Jacinto Battlefield

26. Site 41 CH110
27. Orcoquisac Archaeological Dist.
28. Site 41 LB 4
29. French House Trading Post
30. McFadden House Complex

(continued)

Table 32 (continued)

Additional Sites Chosen by Texas State Board of Review for Submission to the National Register

31. Chambers House
32. Fort Anahuac
33. Historic Indian Village
34. Annunciation Church
35. Cherry House
36. Harris County Boys School Site
37. Noble House
38. Walter G. Ansell House
39. Ball House
40. Building at 2127 Strand
41. Boulevard Dist.
43. Galveston County Museum (Old Moody Bank Building)
44. Hendley Building
45. Menard House
46. Gen. E. B. Nichols Building
47. J. F. Smith House
48. Trube House
49. Williams-Tucker House
50. House at 3301 Avenue L
51. House at 2134 Avenue M
52. House at 3518 Avenue M
53. House at 1725 Avenue M
54. House at 1522 21st Street
55. House at 1502 Market

(Over 600 significant structures in the city of Galveston are recorded in the files of the Texas State Historical Survey Commission.)

56. Levi Jordan Plantation
57. Indianola District
58. Fulton House
59. Fort Polk
60. Stillman House

County & Municipal Parks Along the Texas Gulf Coast

a. Public Beach
b. Fort Anahuac Park
c. Job Benson Park
d. Double Bayou Park
e. McCollum Park
f. Public Beach
g. Bay Shore Park
h. Pelican Island & Seawolf Park
i. Surfside Beach
j. Quintana-Bryan Beach
k. Palacios Park and Fishing Piers
l. Port O'Connor Park
m. Indianola Park
n. Seadrift Bayfront City Park
o. Bayside Park and Pier

(continued)

Table 32 (continued)

| | |
|---|---|
| p. | Rockport Beach |
| q. | Navigation District #2 |
| r. | San Patricio County Park |
| s. | Port Aransas Park |
| t. | Municipal Harbor (Port Aransas) |
| u. | County Fishing Piers (Port Aransas - 2) |
| v. | Breakwater Park |
| w. | OSO Pier |
| x. | Bayfront Park |
| y. | Cole Park |
| z. | Nueces County Park |
| aa. | Kleberg County Park |
| bb. | Loyola Beach |
| cc. | Riviera Beach |
| dd. | Access Road and Parking Area #4 |
| ee. | " " " " " #3 |
| ff. | " " " " " #2 |
| gg. | " " " " " #1 |
| hh. | Andy Bowie Park |
| ii. | Isla Blanca Park No. 1 |

e. Archaeological resources

Evidence of human habitation dating back thousands of years can be found throughout the Gulf region. Archaeological sites are reported in all counties and parishes bordering the Gulf. The total number of sites known and recorded in each county is shown on Visual Graphic No. 4 for the three Gulf zones. Updated information has been received since the printing of the visual for the western Gulf, and with one exception, the number of recorded sites in the Texas coastal counties was increased.

Because of the sensitive nature of the location of archaeological sites, only those major sites which are of general public knowledge or are afforded protection are individually shown on the visuals. These are certain sites on the National Register of Historic Places.

As of January, 1975, the twenty-three Florida counties bordering the Gulf of Mexico contained a total of 2,743 known archaeological sites. Gulf County has the smallest number of recorded sites with only twenty-six and Hillsborough County is highest with 373 sites. It should be emphasized that these figures represent sites recorded by the State Bureau of Historic Sites and Properties, and reflects the present level of knowledge. Numbers will vary greatly due to variation in the intensity of past archaeological research effort and are only suggestive of the magnitude of archaeological resources. Statewide files contain nearly 5,000 entries, but the state archaeologists staff estimates that there may be as many as

700,000 sites in all (W. A. Cockrell, personal communication, 1975).

The two counties facing the Gulf in Alabama have a total of 189 recorded sites. Mississippi's three coastal counties record 106 archaeological sites, and there are 594 known sites in Louisiana parishes bordering the Gulf.

For the sixteen Texas counties adjacent to the Gulf, 1,359 archaeological sites had been recorded by September, 1974. A total of forty-three of these sites had been excavated and an estimated five percent of the total area had been systematically surveyed for archaeological sites. Individual coverage ranged from no systematic survey in Aransas County to approximately fifteen percent coverage in Cameron, Jackson and Kleberg Counties (Texas Archaeological Res. Lab., 1974).

Additional discussion of archaeological resources can be found in the Department of Interior's Final Environment Statements for OCS Sale No. 32, FES 73-60 (MAFLA area), Vol. I, pp. 200-203; OCS Sale No. 38, FES 75-37 (central Gulf), Vol. I, pp. 237-241; and OCS Sale No. 37, FES 74-63 (western Gulf), Vol. I, pp. 355-363.

Submerged archaeological sites: There is increasing interest in submerged sites of archaeological value offshore on the continental shelf or in estuaries and embayments. Because man has inhabited the Gulf coast region for thousands of years, there was human occupation in

the area at a time when sea level was much lower than it has been within historic times.

Florida's State Underwater Archaeologist, Wilburn Cockrell, has assured us of the existence of underwater archaeological sites on Florida's Gulf Coast (W. A. Cockrell, personal communication, 1973). He believes that analysis of these sites will be important in modifying and correcting data in existence regarding the aboriginal inhabitants of the eastern United States, especially in the "archaic" and "lithic" periods representing the earliest cultures in the area. Radio carbon dating of objects retrieved from the Warm Mineral Springs underwater site in Sarasota County has established the presence of human beings in the area as early as 10,000 years ago (Butterfield, 1973).

Six submerged sites off Florida, which are believed to contain evidence of prehistoric habitation, are shown on Figure 26. One site is southwest of Naples off Collier County, one near Venice off Sarasota County, one near Fort Walton Beach of Okaloosa County, and three in Apalachee Bay off Wakulla County.

Shipwrecks: The waters of the northern Gulf of Mexico contain numerous shipwrecks dating back to the early sixteenth century. Considerable

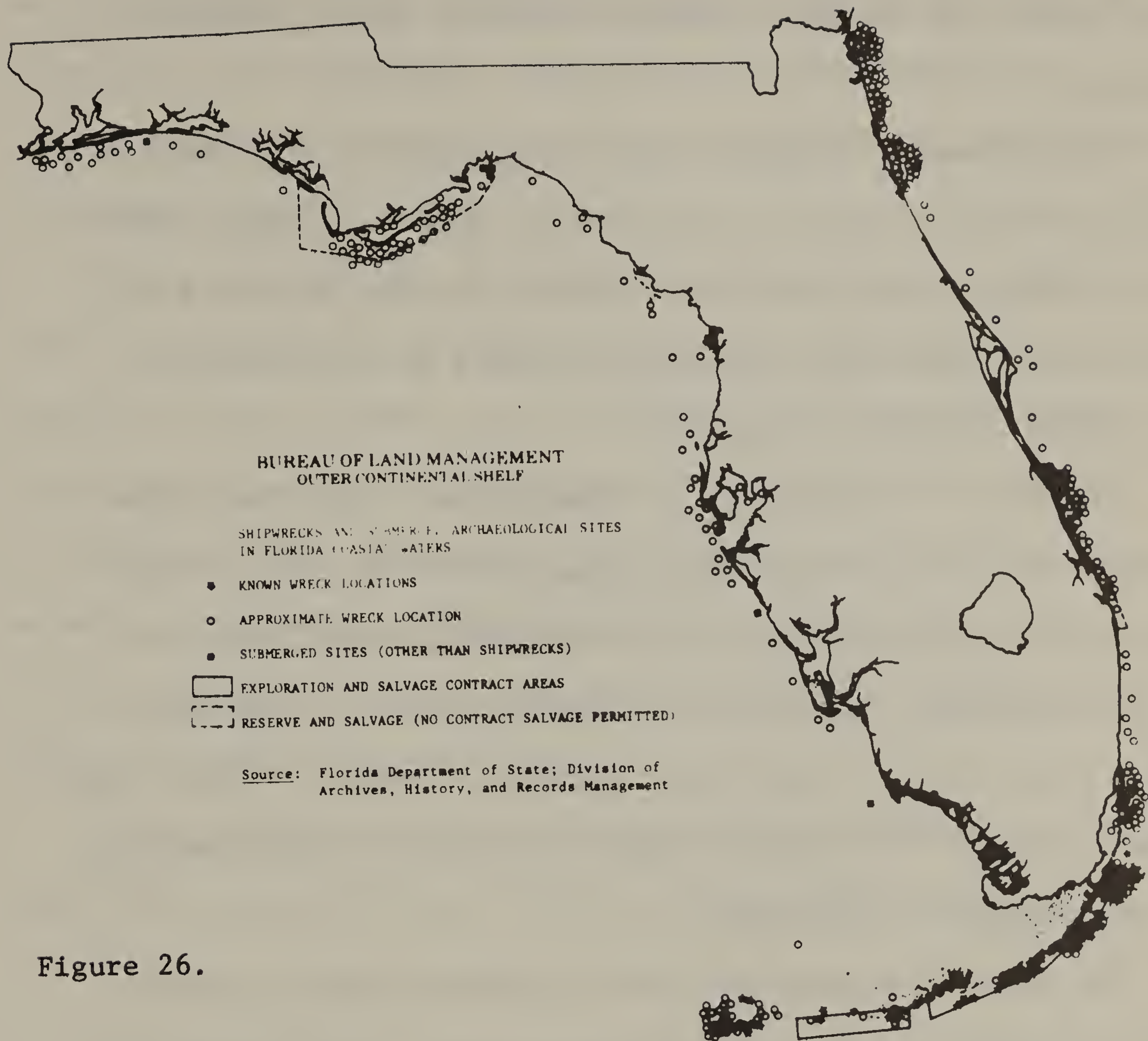

BUREAU OF LAND MANAGEMENT
OUTER CONTINENTAL SHELF
SHIPWRECKS ARCHAEOLOGICAL SITES
IN FLORIDA
KNOWN WRECK LOCATIONS
APPROXIMATE WRECK LOCATION
SUBMERGED SITES (OTHER THAN SHIPWRECKS)
EXPLORATION AND SALVAGE CONTRACT AREAS
RESERVE AND SALVAGE (NO CONTRACT SALVAGE PERMITTED)
Source: Florida Department of State; Division of Archives, History, and Records Management

Figure 26.

work has been done in the archives of Mexico, Spain and many other countries to identify and locate early casualties in the Gulf of Mexico. More modern losses may be identified by the U. S. Navy, Coast Guard, and insurance company records or other contemporary sources.

A Department of Interior study is currently being conducted by Dr. Sherwood Gagliano to determine the zones of highest probability within the northern Gulf of Mexico for the occurrence of historically significant shipwrecks, as well as the potential for submerged human dwelling sites.

Figure 26 , in addition to submerged dwelling sites, shows a generalized plot of shipwrecks along the Florida coast. Shipwrecks of precisely known location are distinguished from those of only approximate location or probable existance. Most shipwrecks occur close to shore where vessels are driven by storm, run aground on shoals or reefs, or where difficulties are encountered in entering bays or estuaries.

The State of Florida may issue to private salvors contracts for the salvage of shipwrecks in state waters. These provide for supervision of the work, conservation and study of the materials recovered, and division of the artifacts between the salvor and the state. Figure 26 shows two areas in the Florida Keys and one along the Atlantic Coast in which such contracts are in effect. In three areas along the Atlantic coast and one large area including Appalachicola Bay, no salvage permits will be issued. These areas

are being studied for inclusion as National Historical Register Districts.

Shipwreck occurrence shows a general clustering in extreme western Florida, and around Appalachicola Bay with a minor concentration around Tampa Bay. The Florida Keys are especially rich in shipwreck sites and several large clusters are found along the Atlantic coast.

Texas is another area of active shipwreck research. Briggs (1971) lists eighty-three known wrecks along the Texas coast dating from 1552 to 1897. Mr. Carl Clausen has conducted extensive underwater surveys in Matagorda Bay and along Padre Island for the Texas State Antiquities Commission. A number of the anomalies discovered are believed to be early shipwrecks, and one site, designated 41KN10, was excavated in 1972 yielding artifacts of an early Spanish galleon.

These surveys, which are being gradually extended along the coast, are conducted close to shore and well within state waters.

4. Ports and Shipping

The ports and harbors along the Gulf coast from Tampa to Corpus Christi are shown in Table 33 to show the magnitude of water borne traffic over the entire area where the oil products originating from the proposed tracts may be transported by barges or tankers.

Of the 506.7 million tons of freight that passed through the 19 ports and harbors in 1973 as shown in Table 33, 238.8 million tons or almost 47 percent was crude oil and petroleum products. Also, of these same 506.7 million tons of freight, 167.1 million tons, or approximately 31 percent moved in foreign trade (imports plus exports) and of this foreign trade 36.5 million tons or 22 percent was crude oil and petroleum products. The Gulf Intercoastal Waterway, a sheltered coastwise channel at least 12 feet deep, traverses the entire area as far east as the eastern end of St. George Island in Franklin County, Florida. The majority of the coastwise barge traffic uses this route and, therefore, does not get out into the open gulf.

A description of the Gulf coast ports is included in Appendix F of this statement.

TABLE 33

FREIGHT TRAFFIC AT MAJOR PORTS
OF THE GULF COAST, TAMPA - CORPUS CHRISTI

Freight Traffic (Short Tons X 1000)
- 1973 -

| Port | Total Freight Traffic | (SIC 13) Crude Petroleum | (SIC 29) Petroleum Products | Total Foreign Trade | Total Petroleum in Foreign Trade | Petroleum Products as a % of Foreign Trade | Petroleum Products in Foreign Trade as a % of Total Port Activity |
|---|---|---|---|---|---|---|---|
| Tampa | 41,923 | 97 | 19,355 | 18,979 | 3,403 | 18 | 08 |
| Panama City | 1,806 | 00 | 1,239 | 605 | 267 | 44 | 15 |
| Pensacola | 2,272 | 41 | 1.620 | 540 | 332 | 61 | 13 |
| Port St. Joe | 669 | 0 | 162 | 190 | 162 | 85 | 24 |
| Mobile | 30,518 | 5,273 | 3,579 | 11,766 | 375 | 03 | 01 |
| Pascagoula | 12,877 | 27 | 6,977 | 2,891 | 19 | 01 | 00.1 |
| Biloxi | 1,246 | 00 | 46 | 00 | 00 | 00 | 00 |
| Gulfport | 989 | 00 | 32 | 896 | 2 | 00.2 | 00.2 |
| New Orleans | 136,104 | 23,236 | 20,925 | 46,472 | 3,490 | 08 | 03 |
| Baton Rouge | 53,568 | 5,115 | 15,870 | 17,442 | 2,107 | 12 | 04 |
| Lake Charles | 16,505 | 7,766 | 3,763 | 2,578 | 1,251 | 45 | 08 |
| Orange | 1,280 | 72 | 61 | 70 | 00 | 00 | 00 |
| Beaumont | 34,491 | 11,342 | 13,865 | 9,618 | 4,908 | 51 | 14 |
| Port Arthur | 24,931 | 7,153 | 14,905 | 6,475 | 4,347 | 67 | 18 |
| Houston | 88,518 | 11,390 | 31,753 | 33,429 | 7,371 | 22 | 08 |
| Texas City | 19,959 | 4,844 | 8,728 | 3,279 | 2,575 | 79 | 13 |
| Galveston | 6,887 | 32 | 319 | 5,250 | 231 | 04 | 03 |
| Freeport | 7,348 | 2,410 | 617 | 3,420 | 1,933 | 57 | 26 |
| Corpus Christi & Harbor Island | 27,171 | 7,225 | 8,569 | 13,067 | 3,765 | 29 | 14 |
| TOTALS | 506,725 | 86,023 | 152,855 | 167,147 | 36,538 | 22% | 07 |

TOTAL PETROLEUM PRODUCTS AS A % OF TOTAL PORT ACTIVITY 47%

5. Transportation Systems

As is shown on the Figure 27, the Gulf Coastal Zone is well served by all forms of transportation. An extensive network of highways and rail lines connect all major ports with inland areas. Transportation throughout the coastal counties is primarily over roads and highways. The following table gives total roads and highways mileage by state and total number of motor vehicle registrations (autos, trucks and buses) by state.

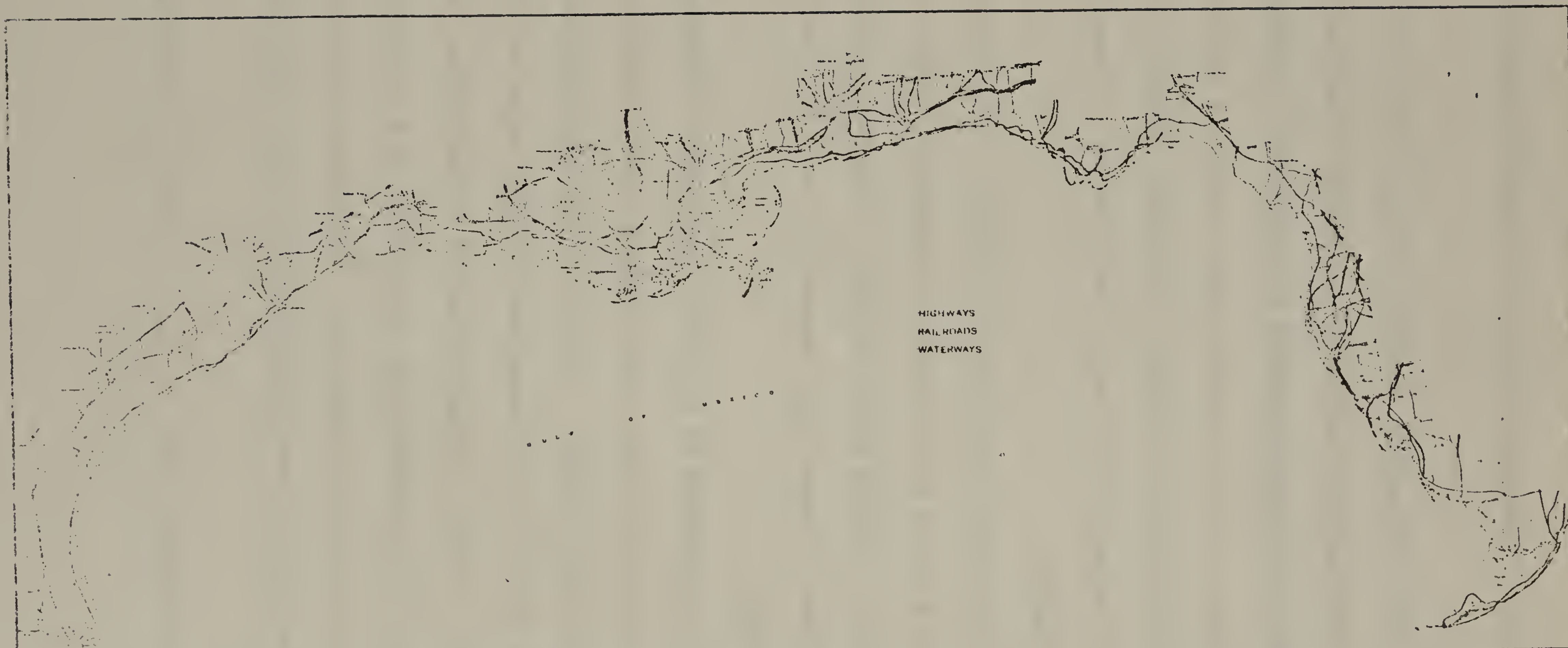
| | Road and highway mileage - 1971 | Motor vehicle registrations - 1972 |
|---|---|---|
| Alabama | 79,036 | 2,227,000 |
| Florida | 93,310 | 4,836,000 |
| Louisiana | 53,340 | 1,942,000 |
| Mississippi | 66,766 | 1,249,000 |
| Texas | 248,340 | 7,316,000 |

(Registration figures rounded to nearest thousand)

From U. S. Federal Highway Administration, Highway Statistics, 1971.

Regional and/or local mass transportation planning is in the early stages in almost all of the Gulf coastal area. Exceptions are the Houston-Galveston, New Orleans and the Tampa-St. Petersburg areas. Even there, mass transit planning is oriented toward motor vehicle transit. A recent bond election in the Houston area failed, possibly because of conflict over administration of a proposed system.

Because of their geographic location, the coastal counties are also served extensively by waterborne transportation systems. A num-




UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

SCALE IN MILES

Figure 27

MAJOR LAND AND SEA TRANSPORTATION ROUTES FOR COASTAL COUNTIES GULF OF MEXICO COASTAL REGION

ber of important U. S. ports are within the Gulf of Mexico coastal area.

The Port of New Orleans is the second largest port in the nation. Houston is the third largest port and the largest inland port in the nation, and the Port of Corpus Christi is the ninth largest U. S. port. The deep water ports along the Texas coastline are Beaumont, Brownsville, Corpus Christi, Freeport, Galveston, Houston, Orange, Port Arthur, Port Isabel, Port Lavaca, Point Comfort, Texas City and Sabine Pass Harbor.

Alabama's only seaport is located in Mobile. By contrast Mississippi has four ports which are located at Pascagoula, Biloxi, Gulfport and Pass Christian. Florida ports include: Cedar Keys, Charlotte, Fort Meyers, Key West, Pamana City, Pensacola, Port St. Joe, St. Petersburg and Tampa.

The ports are connected by the Gulf Intracoastal Waterway consisting of 1,113 miles of canals which extend from Brownsville, Texas to Apalachee Bay, Florida. By way of the Intracoastal Waterway, all ports on the Gulf are also connected to 6,000 miles of inland waterway. However, recent congestion may be an indication that the waterway's capacity for handling the increasing load is being tested. A more complete discussion of waterborne transportation and port activities is contained in Port Activities for Major Gulf Coast Ports, Appendix F.

The major air service needs are met by airport facilities

located in the proximity of the following cities: Brownsville, Beaumont, Port Arthur, Corpus Christi, Freeport, Galveston, Houston, Port Lavaca, Point Comfort, Orange and Texas City, Texas; Baton Rouge and New Orleans, Louisiana; Mobile, Alabama; and Tampa, St. Petersburg, Clearwater, Sarasota, Bradenton and Pensacola, Florida.

6. Commercial Fishery Resources

By far the most productive region of the Gulf of Mexico, where most of the fishery concentrates, is around the Mississippi Delta, with approximately 1/3 to 2/5 of the total production taken on the eastern side (Zuhl, 1974). The total U. S. landings for 1974 were 4.9 billion pounds (U.S. Dept. Commerce, 1975) valued at $898.5 million at the ex-vessel level. Landings in the Gulf waters of the U. S. accounted for 36.1% or 1.77 billion pounds and 26.8% or 240.8 million of the U. S. catch. This is compared to the figures of 1930 when the Gulf production was a mere 5% and 4% in volume and value respectively. As a corollary on a world-wide basis the productivity of the Gulf, specifically the northern area, is considered second only to that of the Peruvian coast. From our present knowledge about the Gulf resources, it is expected that this growth will continue (Zuhl, 1974).

Of the species taken commercially, several features of the Gulf coast catch are worth noting here.

The fishery is dominated by the shellfisheries, and especially by shrimp, crabs and oysters (with smaller amounts of spiny lobsters, clams and scallops), usually worth three to four times more than the much greater volume of finfish. The main shrimp fishery in the Gulf area includes pink, brown and white shrimp. These are taken almost exclusively with trawls, in depths ranging from one to fifty fathoms. Other shrimp taken commercially are the sea bobs and royal reds.

In 1974 the Gulf states fishery accounted for 50 percent of the total volume and 77 percent of the total value. In addition, Texas was again the leading state in value with $67.7 million, and the second state in production with 78.7 million pounds. Louisiana was second in value with $32.1 million, and third in production with 59.5 million pounds.

Compared with 1973, landings along the Gulf coast of 185.7 million pounds increased two percent, but the value ($137.4 million) declined 21 percent. For oyster production, Louisiana led with 9.0 million pounds, followed by the west coast of Florida with 2.4 million and Texas with 1.3 million pounds. The oyster harvest declined generally in the Gulf area, principally because of floods in 1972 and 1973.

Louisiana also led in crab production with 20.6 million pounds. Production for the Gulf states was 39.6 million pounds which represented six percent less than in 1973.

Finfish volume for the Gulf states is dominated by menhaden. This industrial fish, which is processed to produce oil, fish meal and solubles worth ultimately many times the original value of the catch, is number one in both volume and value for the Gulf States. Landings in 1974 were 1,295.9 million pounds - 223.0 million (21 percent) more than in 1973 or 65.5% of the U. S. menhaden catch. Louisiana led all states with 1,079.3 million pounds - up 184.4 million compared with 1973.

The following information was taken primarily from Hopkins and Petrocelli (1974).

Nearly all of the Gulf coast catch, including practically all of the menhaden, is made within the waters of the United States, or in international waters within a few miles of the U.S. coast. Of the important commercial fishes, only groupers and red snappers are caught mainly beyond the 12-mile limit, and they make up only one percent of the volume and two percent of the value of the total Gulf coast catch. However, of the shrimp landed at Gulf ports some 20 percent are caught in international waters off foreign shores, mainly Mexican.

As Gunter (1967) has pointed out, 97.5 percent of the total commercial fisheries catch of the Gulf states is made of estuarine species, that is, fishes or shellfishes that spend all or part of their lives in estuaries. A few species, such as the commercial oyster, live their entire lives in estuarine waters.

Because Gulf coast commercial fisheries are based on species that are mostly estuary-dependent, and in many cases spend their entire lives in waters influenced by runnoff from the land, they are especially vulnerable to pollution. The fresh water of Gulf coast rivers comes from far inland, so it brings in residues of pesticides, defoliants, fertilizers, etc., used to produce crops in millions of acres of farmland. On the way to the Gulf the Mississippi and other rivers receive discharges from many city sewage systems and industrial plants, drainage from oil fields and mines, etc. So far, these contaminants do not seem to have reached the Gulf in concentrations sufficient to conspicuously harm commercial fisheries, but that seems

possible in future if pollution continues to increase.

On the Gulf coast as a whole, the usual ranking of the most important commercial fishes is as shown below:

| By Volume | By Value |
|---|---|
| Menhaden | Menhaden |
| Mullet | Red Snapper |
| Croaker | Mullet |
| Red Snapper | Spotted Seatrout |
| Groupers | Croaker |
| Spanish Mackerel | Groupers |
| Spotted Seatrout | Pompano |
| Red Drum | Spanish Mackerel |
| Flounders | Red Drum |
| Black Drum | Flounders |
| King Whiting | King Mackerel |
| White Seatrout | Black Drum |
| Sheepshead | White Seatrout |
| | Sheepshead |

Table 34 is a statistical summary of landings, fishermen, plants and ranking in the United States for the Gulf states. These statistics were taken from Fisheries of the United States, 1974-Current Fishery Statistics No. 6700 (U.S. Dept. of Comm., 1975).

Table 34. Landings by States for Gulf of Mexico 1973 - 1974 1/

| | 1973 | | | | 1974 | | | |
|---|---|---|---|---|---|---|---|---|
| | Thousand Pounds | % | Thousand Dollars | % | Thousand Pounds | % | Thousand Dollars | % |
| Gulf | 1,547,471 | | 268,146 | | 1,772,531 | | 240,836 | |
| Alabama | 39,749 | 2.6 | 18,080 | 6.8 | 36,962 | 2.1 | 17,087 | 7.1 |
| Florida (Gulf) | 99,200 | 6.4 | 43,462 | 16.2 | 104,662 | 5.9 | 48,245 | 20.0 |
| Louisiana | 1,035,959 | 66.9 | 98,446 | 36.7 | 1,228,906 | 69.3 | 86,694 | 36.0 |
| Mississippi | 271,594 | 17.6 | 16,887 | 6.3 | 304,794 | 17.2 | 16,355 | 6.8 |
| Texas | 100,969 | 6.5 | 91,271 | 34.0 | 97,203 | 5.5 | 72,455 | 30.1 |

1/ Landings in interior waters are estimated.

Ranking in U. S. (1974) by Landings

| State | Catch | Value |
|---|---|---|
| Louisiana | 1 | 3 |
| Texas | 13 | 4 |
| Florida (west coast) | 12 | 8 |
| Alabama | 17 | 14 |
| Mississippi | 5 | 16 |

Number of Full-Time and Part-Time Commercial Fishermen 1974 2/

| | Full-Time | Part-Time | Total |
|---|---|---|---|
| Alabama | 2,071 | 471 | 2,542 |
| Florida 3/ | 9,850 | 2,100 | 11,950 |
| Louisiana | 9,500 | 4,050 | 13,550 |
| Mississippi | 1,981 | 1,529 | 3,510 |
| Texas | 6,500 | 575 | 7,075 |

Processing and Wholesale Establishments, 1973

| State | Processing Plants | Employment Season | Average Year |
|---|---|---|---|
| Alabama | 51 | 1,786 | 1,196 |
| Florida (west coast) | 118 | 3,951 | 3,477 |
| Louisiana | 118 | 4,807 | 3,233 |
| Mississippi | 40 | 1,466 | 1,016 |
| Texas | 80 | 3,430 | 2,483 |

| State | Wholesale Plants | Employment Season | Average Year |
|---|---|---|---|
| Alabama | 11 | 139 | 65 |
| Florida (west coast) | 159 | 482 | 427 |
| Louisiana | 108 | 489 | 391 |
| Mississippi | 20 | 117 | 78 |
| Texas | 80 | 1,491 | 810 |

2/ All data are estimated.

3/ Includes entire state.

Plants Producing Canned and Industrial Fishery Products, and Fish Fillets and Steaks, 1974

| State | Canned Fishery Products | Industrial Fishery Products | Fish Fillets And Steaks | Total Plants Exclusive of Duplication |
|---|---|---|---|---|
| Alabama | - | 1 | 2 | 3 |
| Florida | 2 | 3 | 13 | 18 |
| Louisiana | 17 | 23 | 1 | 40 |
| Mississippi | 9 | 4 | - | 13 |
| Texas | - | 1 | - | 1 |

A graphic representation for the coastal zone and offshore fisheries is in Vol. 3, Graphics 5; western, central and eastern Gulf of Mexico. These graphics illustrate or depict locations of major oyster, sponge, scallop and clam beds for the Gulf. In addition, two year (1972-1973) averages for brown, white and pink shrimp are given and location of royal red shrimp grounds, major inshore shrimp areas, major crabbing areas and spiny lobster grounds are illustrated. Finfish are identified as to major species, both sport and commercial, and grid zones in which they are commonly caught. Shell dredging areas are also identified.

7. Oil and Gas Resources

As of July 31, 1975, there were 5,444 active zone completions in the OCS of the Gulf of Mexico. All of these were located offshore Texas and Louisiana.

As of June 30, 1975 there were 54 drilling rigs operating in the Gulf of Mexico.

Oil and gas production in 1974 from the OCS leases in the Gulf of Mexico accounted for approximately 344 million barrels of oil and condensate, 3.5 trillion cubic feet of gas and two billion gallons of gas liquids, with a total value of $3.2 billion. Since the inception of the OCS leasing program, the cumulative value of offshore production in the Gulf of Mexico through 1974 was more than $18.5 billion.

The OCS is currently producing 11.2 percent of domestic oil production and 16 percent of domestic gas production (U. S. Geological Survey, 1974 and 1975).

All the above data pertains only to leasing occurring on the federal OCS as defined by the Outer Continental Shelf Lands Act (67 Stat. 462).

Oil and gas resources data pertaining to the coastal states bordering the Gulf of Mexico are presented in Tables 62 and 63.

## H. Existing Environmental Quality

### 1. Air Quality

Multiple or massive use of air for waste disposal (emissions) in a limited area temporarily degrades the quality (defined as availability for general use) of the air. Evaluation of the potential impact of a proposed additional use of air involves knowledge of the restrictions on additional impacts, the capability of the air to receive additional impacts and the extent of the proposed additional impacts. The remainder of this section examines the first two factors in terms of the legal constraints involved, and the existing air quality.

Interstate air quality control regions define areas in which specific controls and standards are applied, but which are administered by federal or state jurisdictions. The air quality criteria to be met by a potential pollution source can be complex, in that each air quality jurisdiction may have differing criteria. Thus, conceivably, a source in the Houston, Texas, area would have to meet separate criteria imposed by the federal standards (through EPA Region VI), Texas Air Control Board (Texas Region VII), Harris County Pollution Control Department, and Houston City Pollution Control Division. Table 35 lists the federal ambient air standards. All individual states are required to adopt standards as stringent as or more stringent than the federal standards. Table 36 lists the current regulations in force in the Gulf coast states.

Table 35 Federal Ambient Air Quality Standards

| Parameter | Standard Primary | Secondary |
|---|---|---|
| Particulate Matter: | | |
| Annual geometric mean | 75 ug/m³ 1/ | 60 ug/m³ |
| 24-hour maximum | 260 ug/m³ | 150 ug/m³ |
| Sulfur Oxides: | | |
| Annual arithmetic mean | 80 ug/m³ | |
| 24-hour maximum | 365 ug/m³ | |
| 3-hour maximum | -- | 1.300 ug/m³ |
| Carbon Monoxide: | | |
| 8-hour maximum | 10 mg/m³ 2/ | 10 mg/m³ |
| 1-hour maximum | 40 mg/m³ | 40 mg/m³ |
| Photochemical Oxidants: | | |
| 1-hour maximum | 160 ug/m³ | 160 ug/m³ |
| Hydrocarbons: | | |
| 3-hour maximum | 160 ug/m³ | 160 ug/m³ |
| Nitrogen Dioxide: | | |
| Annual arithmetic mean | 100 ug/m³ | 100 ug/m³ |

1/ $ug/m^3$ = micrograms per cubic meter

2/ $mg/m^3$ = milligrams per cubic meter

Table 36 State Ambient Air Quality Standards

| | Florida | Alabama | Mississippi | Louisiana | Texas |
|---|---|---|---|---|---|
| Suspended Particulate Matter: | | | | | |
| Annual geometric mean | $11^o$ | $1^o/11^o$ | $11^o$ | $1^o$ | $1^o/11^o$ |
| Maximum 24-hour mean | $11^o$ | $1^o/11^o$ | $11^o$ | $1^o$ | $1^o/11^o$ |
| Maximum consecutive 5-hour mean | --- | --- | --- | --- | 100 $ug/m^3$ (a) |
| Maximum consecutive 3-hour mean | --- | --- | --- | --- | 200 $ug/m^3$ (a) |
| Maximum consecutive 1-hour mean | --- | --- | --- | --- | 400 $ug/m^3$ (a) |
| Dustfall | --- | --- | 5.25 $gms/meter^2$/mo | 20 tons per square mile per month | --- |
| Coefficient of Haze: | | | | | |
| Annual geometric mean | --- | --- | --- | 0.6 COH/1000 lin ft | --- |
| Annual arithmetic mean | --- | --- | --- | 0.75 COH/1000 lin ft | --- |
| Maximum 24-hour mean | --- | --- | --- | 1.50 COH/1000 lin ft | --- |
| Sulfur Dioxide ($SO_2$): | | | | | |
| Annual mean | $11^o$ | $1^o/11^o$ | $11^o$ | $1^o$ | $1^o$ |
| Maximum 24-hour mean | $11^o$ | $1^o/11^o$ | $11^o$ | $1^o$ | $1^o$ |
| Maximum 3-hour mean | $11^o$ | $11^o$ | $11^o$ | --- | $11^o$ |
| Maximum 30-minute mean | --- | --- | --- | --- | 0.4 ppm (b)(c) |
| Sulfuric Acid Mist: (Sulfur Trioxide, or any combination thereof) | | | | | |
| Maximum annual mean | --- | --- | --- | 4 $ug/m^3$ | --- |

(Continued)

Table 36 continued

| | Florida | Alabama | Mississippi | Louisiana | Texas |
|---|---|---|---|---|---|
| 24-hour mean (not $>$ 1%) | --- | --- | --- | 12 $ug/m^3$ | --- |
| 1-hour mean (not $>$ 1%) | --- | --- | --- | 30 $ug/m^3$ | --- |
| Carbon Monoxide (CO) | $11^o$ | $1^o/11^o$ | $11^o$ | $1^o$ | $1^o/11^o$ |
| Hydrocarbons (other than Methane) | $11^o$ | $1^o/11^o$ | $11^o$ | $1^o$ | $1^o/11^o$ |
| Total Oxidants | $11^o$ | $1^o/11^o$ | $11^o$ | $1^o$ | $1^o/11^o$ |
| Nitrogen Dioxide ($NO_2$) | $11^o$ | $1^o/11^o$ | $11^o$ | $1^o$ | $1^o/11^o$ |

$1^o$ and $11^o$ refer to the Primary and Secondary Federal Standards.

(a) solid fossil fuel fired steam generators excepted

(b) 0.28 ppm (parts per million) for Harris and Galveston Counties

(c) 0.32 ppm for Jefferson and Orange Counties

Estimates of air pollution emissions for the counties in the Gulf Coast region have been given in the implementation plans prepared by the various states (Louisiana Air Control Commission (LACC), 1972; Texas Air Control Board (TACB), 1973; Florida Department of Pollution Control (FDPC), 1972; Mississippi Air and Water Pollution Control Commission (MAWPCC), 1972. These data are compiled in Tables 37 through 41.1.

The emission data give quantities of pollutants being emitted into the air, and the air pollution potential gives some indication of the likelihood that the emissions will not be satisfactorily dispersed. Theoretically, air quality data should provide a direct measure of the extent of air pollution in a given area. In fact, coverage is incomplete. Most of the data available are from urban areas, with a few exceptions.

Rather than detail such data as is available at the time of this report, the potential user is referred to the SAROAD system of the Environmental Protection Agency. This provides access to all current and past air quality data, and may be assessed through a specific geographic location.

The quality of air over the proposed area can be degraded from several types of sources including exhaust emissions from stationary power units, service vehicles and by accidental release and combustion of oil or gas. Because of the distance of most of the lease areas from shore, the impact from exhaust emissions from offshore facilities would probably be small. However, due to prevailing meterological conditions

from operating facilities in the nearshore tracts air quality degradation could result. To determine the specific effect of emissions on particular areas reference is made to the EPA publication of "Compilation of Air Pollution Emission Factors," 1975.

Table 37 . Air Pollution Emissions Estimates for the Alabama Gulf Coastal Region

| | Emissions in Tons/Year | | | | |
|---|---|---|---|---|---|
| County | Nitrogen Oxides | Sulfur Oxides | Hydrocarbons | Carbon Monoxide | Particulate Matter |
| Baldwin | 7,860 | 9 | 13,026 | 51,900 | 162 |
| Mobile | 92,484 | 193,084 | 40,984 | 156,732 | 84,711 |

Sources: EPA Region IV Data Bank, 1974.

Table 38 . Air Pollution Emissions Estimates for the Florida Gulf Coastal Region

| County | Emissions in Tons/Year | | | | |
|---|---|---|---|---|---|
| | Nitrogen Oxides | Sulfur Oxides | Hydrocarbons | Carbon Monoxide | Particulate Matter |
| Bay | 11,400 | 17,000 | 10,540 | 52,340 | 14,620 |
| Charlotte | 1,946 | 162 | 4,089 | 20,130 | 2,114 |
| Citrus | 20,268 | 57,189 | 2,794 | 12,234 | 4,031 |
| Collier | 2,902 | 115 | 5,190 | 25,120 | 1,711 |
| DeSoto | 1,630 | 259 | 3,557 | 17,531 | 2,121 |
| Dixie | 826 | 24 | 1,073 | 784 | 207 |
| Escambia | 22,930 | 17,700 | 23,270 | 120,200 | 18,920 |
| Franklin | 831 | 25 | 1,132 | 5,520 | 280 |
| Gulf | 2,480 | 14,600 | 1,100 | 3,920 | 3,700 |
| Hernando | 1,506 | 8,611 | 1,843 | 8,899 | 776 |
| Hillsborough | 80,003 | 314,146 | 84,346 | 385,900 | 20,125 |
| Holmes | 880 | 30 | 1,240 | 6,070 | 350 |
| Jefferson | 748 | 24 | 1,570 | 7,746 | 751 |
| Lee | 15,510 | 20,093 | 13,433 | 75,538 | 1,397 |

(continued)

Table 38. Air Pollution Emissions Estimates for the Florida Gulf Coastal Region (Continued)

| County | Emissions in Tons/Year | | | | |
|---|---|---|---|---|---|
| | Nitrogen Oxides | Sulfur Oxides | Hydrocarbons | Carbon Monoxide | Particulate Matter |
| Levy | 2,230 | 497 | 2,573 | 12,240 | 2,020 |
| Manatee | 6,054 | 8,146 | 8,663 | 42,252 | 2,476 |
| Monroe | 5,093 | 1,483 | 3,882 | 18,637 | 321 |
| Okaloosa | 6,780 | 940 | 11,800 | 47,690 | 3,010 |
| Pasco | 4,687 | 7,732 | 5,015 | 24,217 | 1,955 |
| Pinellas | 40,410 | 31,842 | 43,821 | 250,121 | 4,358 |
| Santa Rosa | 3,720 | 9,940 | 4,570 | 20,400 | 1,660 |
| Sarasota | 6,957 | 280 | 13,228 | 75,398 | 2,000 |
| Taylor | 4,094 | 3,270 | 3,132 | 24,304 | 9,841 |
| Wakulla | 2,461 | 1,706 | 1,527 | 6,721 | 826 |
| Walton | 1,820 | 54 | 2,680 | 12,640 | 730 |

Source: Florida Department of Pollution Control: Air Implementation Plan, 1972.

Table 39 . Air Pollution Emissions Estimates for the Lcuisiana Gulf Coastal Region

| Parish | Emissions in Tons/Year | | | | |
|---|---|---|---|---|---|
| | Nitrogen Oxides | Sulfur Oxides | Hydrocarbons | Carbon Monoxide | Particulate Matter |
| Ascension | --- | 12,330 | 13,200 | --- | 534,400 |
| Assumption | --- | 86 | 5,960 | --- | 4,360 |
| Calcasieu | --- | 57,380 | 55,100 | --- | 7,860 |
| Cameron | --- | 25 | 480 | --- | 38 |
| East Baton Rouge | --- | 35,200 | 118,300 | --- | 38,080 |
| West Baton Rouge | --- | 5,980 | 3,430 | --- | 2,690 |
| Iberia | --- | 4,760 | 24,800 | --- | 8,160 |
| Iberville | --- | 4,660 | 57,300 | --- | 2,690 |
| Jefferson | --- | 21,900 | 20,900 | --- | 6,470 |
| La Fourche | --- | 220 | 9,900 | --- | 4,790 |
| Lafayette | --- | 620 | 8,700 | --- | 2,460 |
| Livingston | --- | 110 | 1,930 | --- | 160 |
| Orleans | --- | 6,110 | 24,300 | --- | 7,260 |
| Plaquemines | --- | 20,800 | 5,780 | --- | 1,830 |

(Continued)

Table 39. Air Pollution Emissions Estimates for the Louisiana Gulf Coastal Region (continued)

| Parish | Emissions in Tons/Year | | | | |
|---|---|---|---|---|---|
| | Nitrogen Oxides | Sulfur Oxides | Hydrocarbons | Carbon Monoxide | Particulate Matter |
| St. Bernard | --- | 3,150 | 2,840 | --- | 680 |
| St. Charles | --- | 11,300 | 27,500 | --- | 2,330 |
| St. James | --- | 26,300 | 5,250 | --- | 25,700 |
| St. John the Baptist | --- | 2,170 | 3,420 | --- | 1,460 |
| St. Martin | --- | 150 | 3,870 | --- | 2,440 |
| St. Mary | --- | 5,340 | 82,400 | --- | 7,790 |
| St. Tammany | --- | 220 | 3,550 | --- | 5,850 |
| Tangipahoa | --- | 220 | 3,400 | --- | 750 |
| Terrebonne | --- | 220 | 9,140 | --- | 4,450 |
| Vermilion | --- | 140 | 1,890 | --- | 400 |

Source: Louisiana Control Commission: Louisiana Implementation Plan, 1972.

Table 40 . Air Pollution Emissions Estimates for the Mississippi Gulf Coastal Region

| County | Emissions in Tons/Year | | | | |
|---|---|---|---|---|---|
| | Nitrogen Oxides | Sulfur Oxides | Hydrocarbons | Carbon Monoxide | Particulate Matter |
| Hancock | 1,490 | 28 | 1,850 | 13,150 | 490 |
| Harrison | 34,630 | 28,920 | 15,930 | 101,780 | 5,280 |
| Jackson | 16,920 | 3,460 | 10,420 | 78,400 | 9,020 |
| Pearl River | 2,700 | 160 | 3,280 | 23,260 | 760 |

Source: Mississippi Air and Water Pollution Control Commission: Mississippi Implementation Plan, 1972.

Table 41 . Air Pollution Emissions Estimates for the Texas Gulf Coastal Region

| County | Emissions in Tons/Year | | | | |
|---|---|---|---|---|---|
| | Nitrogen Oxides | Sulfur Oxides | Hydrocarbons | Carbon Monoxide | Particulate Matter |
| Aransas | | 247 | 5,010 | 120,660 | 340 |
| Brazoria | 4,395 | 8,124 | 116,658 | 169,006 | 3,930 |
| Calhoun | 1,375 | 263 | 23,209 | 258 | 9,313 |
| Cameron | | | 12,422 | 5,174 | 640 |
| Chambers | 70 | | 1,038 | 3,348 | 1,710 |
| Galveston | 2,558 | 10,643 | 65,167 | 114,128 | 6,712 |
| Harris | 11,962 | 119,473 | 156,058 | 436,418 | 57,727 |
| Jackson | | | 3,992 | | 420 |
| Jefferson | 6,449 | 71,370 | 130,366 | 326,603 | 11,368 |
| Kenedy | | | 685 | | |
| Kleberg | | | 7,616 | | 92 |
| Matagorda | 1,715 | 1 | 7,225 | 1,931 | 820 |
| Nueces | 244 | 2,274 | 49,736 | 156,423 | 4,838 |
| Orange | 1,505 | 4,267 | 24,157 | 79,212 | 5,360 |

(continued)

Table 41. Air Pollution Emissions Estimates for the Texas Gulf Coastal Region (continued)

| County | Emissions in Tons/Year | | | | |
|---|---|---|---|---|---|
| | Nitrogen Oxides | Sulfur Oxides | Hydrocarbons | Carbon Monoxide | Particulate Matter |
| Refugio | | | 660 | | 179 |
| San Patricio | | 1,409 | 843 | 1 | 5,088 |
| Victoria | 1,930 | | 14,122 | 13,503 | 211 |
| Willacy | | | 199 | | 744 |

Source: Texas Air Control Board: Texas Implementation Plan, 1972.

Table 41.1 1972 Emissions Inventory Summary -- for Air Quality Control Regions - Texas

| | Emissions in Tons/Year | | | | |
|---|---|---|---|---|---|
| AQCR | Particulates | Sulfur Oxides | Nitrogen Oxides | Hydrocarbons | Carbon Monoxide |
| 4 Brownsville | 8,245 | 5,747 | 36,214 | 52,451 | 141,650 |
| 5 Corpus Christi | 35,252 | 21,634 | 185,017 | 299,590 | 538,416 |
| 7 Houston-Galveston | 122,468 | 195,465 | 399,575 | 786,359 | 1,526,593 |

Population and industrial-chemical centers are isolated problem areas. Table 42 lists the Air Quality Control Regions which have exceeded the national ambient air quality standards. In almost every case, the data are from sampling points located in urban or industrial areas. The trends shown in Table 42 are based on very limited data. More extensive, although still limited, are the data available from SAROAD. However, the emission estimates in Table 37 through 41.1 are most useful for estimating air quality. Thus, a high carbon monoxide emission level is indicative of high automotive density; and a high hydrocarbon level may indicate petroleum, storage, refining, etc.

The Texas Implementation Plan of 1972 indicated some difficulties in several ACQR's. The following table indicates the priorities assigned to these coastal regions for specific pollutants. Priority I indicates measurements above the primary standards and the requirement for controls to reduce pollutant concentrations.

| | Brownsville (213) | Corpus Christi (214) | Houston (216) | S. Louisiana (106) |
|---|---|---|---|---|
| Sulfur Dioxide | III | I | I | I |
| Particulate | III | II | I | II |
| Oxidants | III | I | I | I |

This information reflects the region classification as submitted in the original Implementation Plan and the semi-annual updates to this plan through August 15, 1975.

Therefore, in lieu of the above data it is recognized that there is a severe air quality problem along the Texas coast. Since the Texas Implementation Plan of 1972 new and more improved measurement methods have been developed. This allowed for a more accurate recording of the ozone levels in the ACQR's.

Table 42. Summary of Air Quality Control Regions (AQCR) Exceeding National Ambient Air Quality Standards

| | NUMBER OF OCCURRENCES WHEN LEVELS EXCEEDED THE AIR QUALITY STANDARDS | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | AQCR #005 | | | AQCR #049 | | | AQCR #050 | | | AQCR #051 | | | AQCR #052 | | | AQCR #106 | | | AQCR #213 | | | AQCR #214 | | | AQCR #216 | | |
| | Mobile-Pensacola-Panama City-S. Miss. (Ala-Fla-Miss) (Includes Alabama State Region 5) | | | Jacksonville-Brunswick (Fla-Ga) | | | Southeast Florida | | | Southwest Florida | | | West Central Florida | | | Southern Louisiana-Southeast Texas (La-Texas)(Includes Texas State Reg. 10) | | | Brownsville-Laredo (Texas) (Includes Texas State Region 4) | | | Corpus Christi-Victoria (Texas) (Includes Texas State Region 5) | | | Metropolitan Houston-Galveston (Texas) (Includes Texas State Region 7) | | |
| POLLUTANTS | 1969 | 1970 | 1971 | 1969 | 1970 | 1971 | 1969 | 1970 | 1971 | 1969 | 1970 | 1971 | 1969 | 1970 | 1971 | 1969 | 1970 | 1971 | 1969 | 1970 | 1971 | 1969 | 1970 | 1971 | 1969 | 1970 | 1971 |
| SULFUR DIOXIDE | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Annual | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| No. greater than the secondary standard (60 ug/m$^3$ = 0.02 ppm) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| No. greater than the primary standard (80 ug/m$^3$ = 0.03 ppm) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 24-hour mean | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| No. greater than the secondary standard (260 ug/m$^3$ = 0.1 ppm) | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| No. greater than the primary standard (365 ug/m$^3$ = 0.14 ppm) | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3-hour mean | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| No. greater than the standard (1300 ug/m$^3$ = 0.5 ppm) | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

(contd)

Table 42. Summary of Air Quality Control Regions (AQCR) Exceeding National Ambient Air Quality Standards

| | NUMBER OF OCCURRENCES WHEN LEVELS EXCEEDED THE AIR QUALITY STANDARDS | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | AQCR #005 Mobile-Pensacola-Panama City-S. Miss. (Ala-Fla-Miss) (Includes Alabama State Region 5) | | | AQCR #049 Jacksonville-Brunswick (Fla-Ga) | | | AQCR #050 Southeast Florida | | | AQCR #051 Southwest Florida | | | AQCR #052 West Central Florida | | | AQCR #106 Southern Louisiana-Southeast Texas (La-Texas)(Includes Texas State Reg. 10) | | | AQCR #213 Brownsville-Laredo (Texas) (Includes Texas State Region 4) | | | AQCR #214 Corpus Christi-Victoria (Texas) (Includes Texas State Region 5) | | | AQCR #216 Metropolitan Houston-Galveston (Texas) (Includes Texas State Region 7) | | |
| POLLUTANTS | 1969 | 1970 | 1971 | 1969 | 1970 | 1971 | 1969 | 1970 | 1971 | 1969 | 1970 | 1971 | 1969 | 1970 | 1971 | 1969 | 1970 | 1971 | 1969 | 1970 | 1971 | 1969 | 1970 | 1971 | 1969 | 1970 | 1971 |
| SUSPENDED PARTICULATES | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Annual | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| No. greater than the secondary standard (60 ug/m$^3$) | 2 | 0 | 0 | 5 | 5 | 8 | 3 | 1 | 1 | 0 | 0 | 0 | 2 | 1 | 0 | 4 | 4 | 2 | 1 | 3 | 0 | 0 | 1 | 0 | 4 | 3 | 2 |
| No. greater than the primary standard (75 ug/m$^3$) | 2 | 0 | 0 | 4 | 3 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 3 | 0 | 0 | 0 | 0 | 3 | 2 | 2 |
| 24-hour mean | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| No. greater than the secondary standard (150 ug/m$^3$) | 3 | 1 | 1 | 4 | 5 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 3 | 3 | 0 | 0 | 0 | 1 | 1 | 8 |
| No. greater than the primary standard (260 ug/m$^3$) | 0 | 0 | 0 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |

(contd)

Table 42. Summary of Air Quality Control Regions (AQCR) Exceeding National Ambient Air Quality Standards

| | NUMBER OF OCCURRENCES WHEN LEVELS EXCEEDED THE AIR QUALITY STANDARDS | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | AQCR #005 | | | AQCR #049 | | | AQCR #050 | | | AQCR #051 | | | AQCR #052 | | | AQCR #106 | | | AQCR #213 | | | AQCR #214 | | | AQCR #216 | | |
| | Mobile-Pensacola-Panama City-S. Miss. (Ala-Fla-Miss) (Includes Alabama State Region 5) | | | Jacksonville-Brunswick (Fla-Ga) | | | Southeast Florida | | | Southwest Florida | | | West Central Florida | | | Southern Louisiana-Southeast Texas (La-Texas)(Includes Texas State Reg. 10) | | | Brownsville-Laredo (Texas) (Includes Texas State Region 4) | | | Corpus Christi-Victoria (Texas) (Includes Texas State Region 5) | | | Metropolitan Houston-Galveston (Texas) (Includes Texas State Region 7) | | |
| POLLUTANTS | 1969 | 1970 | 1971 | 1969 | 1970 | 1971 | 1969 | 1970 | 1971 | 1969 | 1970 | 1971 | 1969 | 1970 | 1971 | 1969 | 1970 | 1971 | 1969 | 1970 | 1971 | 1969 | 1970 | 1971 | 1969 | 1970 | 1971 |
| CARBON MONOXIDE | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1-hour standard | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| No. greater than the standard (40 mg/m$^3$ = 35 ppm) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8-hour standard | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| No. greater than the standard (10 mg/m$^3$ = 9 ppm) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OXIDANTS | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1-hour standard | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| No. greater than the standard (160 ug/m$^3$ = 0.08 ppm) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

* Adapted from Table 309 (EPA, 1973).
ug/m$^3$ = micrograms per cubic meter.
mg/m$^3$ - milligrams per cubic meter.
ppm = parts per million (by volume)

a. Texas

Texas has a severe ozone problem. The standard doesn't allow the ozone level to exceed 0.08 parts per million (ppm) for more than one hour in a calendar year. The majority of the measurements have been made in the upper Gulf Coast area of Texas. This is the region where most of the photochemical industries and metropolitan area are concentrated.

Ozone concentrations vary according to such things as: time of day, season, and weather conditions. During the sunlight hours and the sunny summer months the ozone level increases. Weather also plays a major role in ozone production. High winds usually keep ozone low while relatively stagnant air is conducive to high ozone levels.

The highest ozone level recorded in Texas was 0.42 ppm, measured in August of 1972 in Houston. In every major city in the state where the monitoring of ozone was conducted it showed a high and second high hourly value in excess of the standard of 0.08 ppm. at one time or another in the year. However, in the 21,000 hours of monitoring only 700 recordings showed levels in excess of 0.08 ppm. This indicates the total ozone exposure experienced by Texans is low despite the occasionaly high levels.

Following is a list of coastal area ozone summaries indicating the second highest ozone hours recorded to date at the various sites.

| Location | Value (ppm.) |
|---|---|
| Houston | 0.256 |
| Oldine | 0.300 |
| Texas City | 0.234 |
| Clute | 0.155 |
| Nederland | 0.325 |
| West Orange | 0.195 |
| Corpus Christi | 0.184 |

Source: Texas Air Control Board, 1975

2. Water Quality

The federal agencies responsible for water quality are the Environmental Protection Agency (EPA) and the U. S. Army Corps of Engineers. The Corps of Engineers has authority to issue permits for industrial dischargers and dredge disposal areas for marine water bodies. Unfortunately, almost all of the water quality data that has been collected by the Corps has not yet been quantified and is not available in a usable form. The EPA, now the primary federal pollution control agency, is presently issuing discharge permits to industries and municipalities and has begun to quantify the data through its Data Retrieval Program (RAPP). The two regional offices for the Gulf coast area are Atlanta, Georgia (Region IV), serving Mississippi, Alabama and Florida; and Dallas, Texas (Region VI), serving Texas and Louisiana. However, only scant preliminary data is now available (and only from the Atlanta regional office).

At present, very little data is available from state sources for Louisiana, Mississippi, and Alabama. Most of the data available from these states pertain to point sources of pollution and amount of discharge. Texas and Florida, however, have extensive data available, dealing not only with point sources and amount of discharge, but BOD (biochemical oxygen demand), TSS (total suspended solids), etc. The various agencies responsible for water pollution control in each of the states are: Alabama - Alabama Water Improvement Commission; Florida - Florida Department of Pollution Control; Louisi-

ana - Louisiana Wildlife and Fisheries Commission, Department of Pollution Control (industrial), and the Louisiana Department of Health, Bureau of Environmental Health (municipal); Mississippi - Mississippi Air and Water Pollution Control Commission; and Texas - Texas Water Quality Board and Texas Water Development Board.

Tables 43 through 47 summarize water pollution data for all coastal counties of Alabama, Florida, Louisiana, Mississippi and Texas, respectively, including such parameters as BOD and TSS for both municipal and industrial sources. In all cases, the amount of discharge per county is expressed in millions of gallons per day (MGD). This figure is merely an expression of the amount of liquid water the dischargers in each coastal county are contributing to the Gulf of Mexico or to streams leading to the Gulf. BOD (biochemical oxygen demand) is a measure of the amount (in pounds per day per county) of dissolved oxygen (DO) consumed during the breakdown of organic matter in water by biological processes and organisms. TSS (total suspended solids) is simply an indication of the amount of solid, particulate matter suspended in water and is also measured here in pounds per day per county. Measurements of BOD and TSS are the most widely utilized parameters of water quality of a body of water. Water with excessive BOD and TSS amounts are considered to be polluted because of adverse effects to normally-occurring aquatic organisms.

As can be seen from Tables 43 through 47, the areas of heaviest water pollution are, of course, in major metropolitan areas of

Table 43 . Municipal and Industrial Effluents for Alabama Coastal Counties

| County | Industrial M.G.D.[1] | Industrial B.O.D.[2] | Industrial T.S.S.[3] | Municipal M.G.D. |
|---|---|---|---|---|
| Baldwin | 5.5 | 1,223 | 557 | 1.3 |
| Mobile | 47.5 | 151,055 | 162,729 | 41.3 |

1/M.G.D. = million gallons per day
2/B.O.D. = biological oxygen demand, pounds per day
3/T.S.S. = total suspended solids, pounds per day

Source: Environmental Protection Agency Region IV, Data Bank, 1974.

Table 44. Municipal and Industrial Effluents for Florida Coastal Counties

| County | Industrial | | | Municipal | | |
|---|---|---|---|---|---|---|
| | M.G.D.[1/] | B.O.D.[2/] | T.S.S.[3/] | M.G.D. | B.O.D. | T.S.S. |
| Bay | 302.00 | 241,701 | 150,606 | 5.70 | 1,694 | 794 |
| Charlotte | --- | --- | --- | 2.10 | 415 | 415 |
| Citrus | --- | 2 | 3 | 1.00 | 229 | 229 |
| Collier | --- | 11 | 7 | 3.00 | 1,225 | 1,227 |
| DeSoto | 1.20 | 940 | 278 | .90 | 343 | 343 |
| Dixie | .03 | 18 | 5 | .05 | 25 | 28 |
| Escambia | 365.20 | 416,466 | 38,716 | 8.70 | 944 | 1,737 |
| Franklin | --- | --- | --- | 1.00 | 306 | 361 |
| Gulf | --- | --- | --- | 1.00 | --- | --- |
| Hernando | .05 | 2 | --- | .70 | 204 | 101 |
| Hillsborough | 29.50 | 816 | 903 | 54.40 | 35,826 | 65,940 |
| Jefferson | .20 | --- | --- | .20 | 48 | 43 |
| Lee | --- | 23 | 23 | 8.50 | 2,828 | 3,721 |
| Levy | 118.00 | --- | --- | .40 | 63 | 128 |

(continued)

Table 44. Municipal and Industrial Effluents for Florida Coastal Counties (continued)

| County | Industrial M.G.D. | Industrial B.O.D. | Industrial T.S.S. | Municipal M.G.D. | Municipal B.O.D. | Municipal T.S.S. |
|---|---|---|---|---|---|---|
| Manatee | 1.10 | 5,226 | 61 | 13.20 | 2,745 | 3,345 |
| Monroe | --- | --- | --- | .02 | 1,043 | 1,056 |
| Okaloosa | 3.40 | 548 | 999 | 6.20 | 1,557 | 1,266 |
| Pasco | 38.30 | 6,065 | 708 | 2.90 | 194 | 200 |
| Pinellas | 567.00 | 640 | 5,759 | 79.70 | 14,843 | 16,571 |
| Santa Rosa | 5.50 | 7,710 | 990 | 1.40 | 1,027 | 1,115 |
| Sarasota | .002 | 5 | 5 | 11.70 | 3,024 | 3,390 |
| Taylor | 7.10 | 111,700 | 28,570 | 2.10 | 51 | 40 |
| Wakulla | 202.00 | 75 | 90 | .20 | 14 | 14 |
| Walton | --- | 1,042 | 1,021 | .30 | 78 | 41 |

[1] M.G.D. = million gallons per day
[2] B.O.D. = biological oxygen demand, pounds per day
[3] T.S.S. = total suspended solids, pounds per day

Source: State of Florida, Department of Pollution Control, State Water Pollution Work Plan for 1974.

Table 45 . Municipal and Industrial Effluents for Louisiana Coastal Parishes

| Parish | Industrial M.G.D. 1/ | Municipal M.G.D. |
|---|---|---|
| Calcasieu | 419.2 | 10.7 |
| Cameron | 0.2 | 0.2 |
| Iberia | --- | 0.2 |
| Jefferson | 288.0 | 3.5 |
| La Fourche | 266.0 | --- |
| Orleans | 81.5 | 80.5 |
| Plaquemines | 161.0 | 3.0 |
| St. Bernard | 7.2 | 12.8 |
| St. Mary | --- | 4.1 |
| St. Tammany | --- | 1.3 |
| Terrebonne | 0.7 | 5.6 |
| Vermilion | --- | 1.2 |

1/ M.G.D. - million gallons per day

Source: Cooperative Gulf of Mexico Estuarine Inventory and Study, Louisiana, 1971.

Table 46. Municipal and Industrial Effluents for Mississippi Coastal Counties

| County | Industrial | | | Municipal |
|---|---|---|---|---|
| | M.G.D. 1/ | B.O.D. 2/ | T.S.S. 3/ | M.G.D. |
| Hancock | .09 | --- | --- | --- |
| Harrison | 3.6 | 12,933 | 6,101 | 10.1 |
| Jackson | 75.4 | 292,529 | 636,531 | 8.6 |

1/ M.G.D. = million gallons per day
2/ B.O.D. = biological oxygen demand, pounds per day
3/ T.S.S. = total suspended solids, pounds per day

Source: State of Mississippi Air and Water Pollution Control Commission, 1973.

Table 47 . Municipal and Industrial Effluents for Texas Coastal Counties

| County | Industrial M.G.D. 1/ | Industrial B.O.D. 2/ | Industrial T.S.S. 3/ | Municipal M.G.D. | Municipal B.O.D. | Municipal T.S.S. |
|---|---|---|---|---|---|---|
| Aransas | --- | --- | --- | 1.4 | 564 | 867 |
| Brazoria | 26.40 | 2,327 | 1,112 | 9.9 | 2,902 | 2,970 |
| Calhoun | 20.10 | 2,152 | 15,823 | 2.3 | 707 | 693 |
| Cameron | 88.10 | 2,636 | 20,678 | 15.2 | 8,705 | 8,243 |
| Chambers | 3.90 | 847 | 462 | .2 | 86 | 197 |
| Galveston | 125.20 | 112,767 | 300,620 | 15.0 | 16,283 | 11,257 |
| Harris | 336.00 | 554,260 | 555,831 | 197.4 | 75,443 | 128,721 |
| Jackson | --- | --- | --- | .7 | 130 | 166 |
| Jefferson | 210.00 | 183,174 | 130,801 | 66.0 | 23,258 | 12,575 |
| Kenedy | --- | --- | --- | --- | --- | --- |
| Kleberg | --- | --- | --- | 2.1 | 685 | 633 |
| Matagorda | 6.20 | 9,846 | 2,812 | 2.7 | 1,215 | 440 |
| Nueces | 197.00 | 65,106 | 76,935 | 28.5 | 11,825 | 5,980 |
| Orange | 130.20 | 151,395 | 91,919 | 7.3 | 4,345 | 1,406 |
| Refugio | .04 | 1 | 4 | 0.9 | 476 | 664 |

(continued)

Table 47. Municipal and Industrial Effluents for Texas Coastal Counties (continued)

| County | Industrial M.G.D. | Industrial B.O.D. | Industrial T.S.S. | Municipal M.G.D. | Municipal B.O.D. | Municipal T.S.S. |
|---|---|---|---|---|---|---|
| San Patricio | 0.30 | 24 | 35 | 3.3 | 1,753 | 2,373 |
| Victoria | 35.80 | 6,755 | 13,010 | 3.9 | 951 | 3,078 |
| Wharton | 1.60 | 34 | 336 | 1.8 | 751 | 649 |
| Willacy | --- | --- | --- | 1.0 | 76 | 54 |

1/ M.G.D. = million gallons per day
2/ B.O.D. = biological oxygen demand, pounds per day
3/ T.S.S. = total suspended solids, pounds per day

Source: Texas Water Quality Board, Texas Water Development Board.

the coast, and, furthermore, in areas of concentrated petrochemical industries. Other less important sources of water pollution are fish oil processing plants, pulp and paper mills, and foundries and smelters. As might be expected, municipal pollution is a major source of pollution in several major metropolitan areas: Houston, New Orleans and Mobile.

## I. Historical and Projected Economic Growth

### 1. Introduction

The acreage to be offered in Lease Sale No. 41 is located on the Outer Continental Shelf within an area extending from Corpus Christi, Texas to Tampa, Florida. The largest portion of the acreage lies off the Florida coast, but a substantial number of tracts lie off the coast of Texas as well as Louisiana.

The areal extent of the industrial and economic effects that may result from this sale are difficult to delineate, due to the fact that the Gulf of Mexico area is a major supplier of crude oil, petroleum products and natural gas to other regions of the United States. The following discussion is limited to the onshore areas adjacent to the lease sale region since the initial economic effects may be assumed to impinge on these sectors.

Additional discussions of the economy in the states adjacent to the Gulf of Mexico have been published recently in the following publications.

a. Final Environmental Statement, FES 73-60, OCS Sale No. 32, Offshore Mississippi, Alabama and Florida.

b. Final Environmental Statement, FES 74-63, OCS Sale No. 37, Offshore Texas.

c. Final Environmental Statement, FES 75-37, OCS Sale No. 38, Offshore Central Gulf.

d. Draft Environmental Statement, DES 74-90, Outer Continental Shelf.

The economic activity that has occurred in the areas bordering the Gulf of Mexico has been a significant part of the total economic activity of the nation.

The states bordering the Gulf of Mexico include Texas, Louisiana, Mississippi, Alabama and Florida. The coastal area of Texas will be considered to be the western Gulf of Mexico region, the coastal portion of Louisiana will be considered to be the central Gulf of Mexico region, and the coastal portions of Mississippi, Alabama and the western part of the coastal region of Florida will be considered to be the eastern Gulf of Mexico.

The historical changes that have occurred within the economies of the states bordering the Gulf of Mexico are summarized in the following passages. These descriptions were based on statistical data provided in the Texas Almanac, 1974-1975, published by the A. H. Belo Corporation and publications of the Research Department of the Federal Reserve Bank of Atlanta (1972), supplemented by additional information relating to current economic conditions.

### a. Alabama

Selected portions of the economic activity for Alabama are presented in Table 48. During 1967, approximately 29,000 persons were employed in retail trade establishments in a multi-county area in the southwestern portion of the state. An additional 8,000 were employed in wholesale trade establishments. During 1970, approximately 29 percent of the civilian employment in Alabama was in the

Table 48. Economic Activity for Alabama

| | 1962 | 1972 |
|---|---|---|
| Per capita personal income | $ 1,600 | $ 3,420 |
| Total personal income | $ 5,317 | $12,004 (million) |
| Total cash farm income | $ 573 | $ 988 (million) |
| Cash farm receipts from crops | $ 218 | $ 303 (million) |
| Cash farm receipts from livestock and products | $ 332 | $ 616 (million) |
| Farm population in southwestern Alabama | 12,442 | 19,432 1/ 2/ |
| Coal production | 12,880 | 17,945 3/ (thousand net tons) |
| Petroleum production | 7,473 | 9,889 (thousand bbls.) |
| Value added: manufactured goods | 2,075 | 4,531 (million) |
| Value of construction | $ 721 | $ 1,355 (million) |
| Manufacturing employment | 240 | 328 (thousand) |
| Construction employment | 41 | 57 (thousand) |

---

1/ 1960, increased farm population in the Gulf truck farm region
2/ 1970
3/ 1970

manufacturing category. Approximately half of the employment in manufacturing was in the production of durable goods, particularly in the metal industries. The largest percentage of employment in the manufacturing of nondurable goods was in the category of textiles and textile products.

A recent review of the economy of Alabama by Gunther (1975b) stated: "Certainly a strong note for the future is the presence of vast coal deposits and potential oil reserves in and off the coast of Alabama. The industrial mix of the state should prevent any serious declines in employment in the near future with the expected strengths of the steel, paper, mining, chemical and petroleum industries serving as a floor on future unemployment in the state. Construction, one of the most severely depressed industries in the state, has probably seen the worst in the current slump and should begin regaining strength this year."

b. Florida

Selected portions of the economic activity for Florida are presented in Table 49. During 1970, approximately 54 percent of the employment in manufacturing was in the category of durable goods. Approximately 11 percent of the manufacturing employment occurred in the metal industries, and an additional 11 percent of the employment occurred in the electrical machinery industry. An important industry in the nondurable goods manufacturing category is the production of food and kindred products. Approximately 4.5 percent of the

Table 49 . Economic Activity for Florida

| | 1962 | 1972 |
|---|---|---|
| Per capita personal income | $ 2,022 | $ 4,378 |
| Total personal income | $11,039 | $31,779 (million) |
| Cash farm receipts from crops | $ 676 | $ 1,199 (million) |
| Cash farm receipts from livestock and products | $ 213 | $ 464 (million) |
| Petroleum production | 419 | 16,897 (thou. bbls.) |
| Value of construction | $ 1,642 | $ 6,522 (million) |
| Manufacturing employment | 222 | 335 (thousand) |
| Construction employment | 110 | 204 (thousand) |

total civilian employment in Florida was in the category of wholesale trade, and approximately 19 percent of the civilian employment was in the category of retail trade. During 1967, total retail sales in Florida amounted to $10,280 millions of dollars.

The economy of Florida reflected the downturn noted in the national economy, and during the last three quarters of 1974 the unemployment rate increased from 5.1 during the second quarter to 7.3 during the fourth quarter. During the same period of time, nonagricultural employment declined from 2,776.7 thousands to 2,741.3 thousands of workers. Farm employment remained during October and November at about the same level as during the previous year, and farm cash receipts during October, 1974 were higher than the previous year.

The main source of Florida's unemployment has been in the building trades, due to the decrease in the amount of building. "Motels and condominiums are in considerable oversupply in many areas; bankruptcies and foreclosures have already occurred and more are likely to follow" (Jackson, 1975).

During the period 1967 to 1972, the most rapidly growing manufacturing industry in the state in terms of value added was textile mill products. Other fast-growing groups are petroleum and coal products, apparel and other textile products, printing and publishing and furniture and fixtures (Thompson, 1972).

Much of Florida's major manufacturing is resource-oriented: food, tobacco, lumber and wood products, paper chemicals and stone,

clay and glass products (Thompson, 1975).

Other industries tend to locate close to consumers of the products. These market-oriented industries in Florida include apparel, furniture, printing and publishing, fabricated metal products and machinery. As the population of Florida increases, continued growth of consumer oriented industries appears probable.

"During the 1960 decade, Florida had the United States' third fastest rate of growth for the population aged sixty and older. Florida's elderly population (those persons aged 60 and older) increased twice as rapidly as its total population between the census counts in 1960 and 1970" (Kincaid, 1975).

The rate of growth experienced varied according to age group, white or non-white, and whether classified as urban or rural. The rate of growth between 1950 and 1970 decreased for whites and in most cases, for non-whites, however, the 65 to 74 year and the 85 years and over group for both urban and rural non-whites had an increasing growth rate over the twenty year period. Some generalizations concerning the elderly population include: 1) the percentage change in population is greater for elderly women than for elderly men; 2) the older age groups of elderly people are growing more rapidly than the younger elderly people; and 3) the growth in the white population is much larger than the non-white population.

The article concludes that the growth of the 60 and older population implies both benefits and costs to the economy of Florida. The infusion of more money may benefit the economy, however, the incomes

of these people are relatively fixed, and in inflationary times, the purchasing power, and benefit to the economy of these incomes may diminish.

Most of the counties that doubled their elderly population between 1960 and 1970 lies on the coast of Florida, and the growth in urban areas is considerably greater than the growth in rural areas. One possible reason for the grwoth of the elderly population in urban areas may have been the availability of medical care, social services and other conveniences. The counties having the highest percentage of elderly to total population include Charlotte, Pasco, Manatee, Sarasota, Pinellas, and Citrus, all located on the western coast of Florida. Two generalizations that may be drawn from an analysis of the distribution of Florida's elderly population are that the coastal areas have a strong drawing effect on the elderly, and that the elderly seek readily available housing and not necessarily inexpensive housing.

According to the 1973 County Business Patterns data published for Florida (Table 49.1), there were approximately 38,028 employees of manufacturing firms, 35,397 employees of contract construction firms, and 196 employees of firms engaged in mining activity within the six county area. The additional employment impact that might result from this sale may be considered an incremental addition to the existing work force in the area, and many of the services required would possibly be provided by individuals present with the six county area.

Table 49.1

| | All Employees | Manufacturing | Contract Construction | Mining |
|---|---|---|---|---|
| Charlotte | 6,547 | 193 | 844 | 0 |
| Citrus | 5,225 | 238 | 2,097 | 72 |
| Manatee | 20,862 | 4,837 | 2,376 | D |
| Pasco | 14,137 | 2,812 | 2,067 | 0 |
| Pinellas | 164,118 | 25,153 | 21,673 | 124 |
| Sarasota | 43,549 | 4,795 | 6,340 | D |
| Total 6 Counties | 254,438 | 38,028 | 35,397 | 196 |

Source: U. S. Dept. of Commerce, 1973c.

The Florida Statistical Abstract 1974, Published by the University of Florida press, provided the following summary of employment obtained from the Bureau of the Census publication, County Business Patterns, 1972.

Employment in Tourist Related Businesses

| | Number of Persons |
|---|---|
| 1. Passenger transportation | |
| Local and interurban transit | 7,375 |
| Air transportation and services | 32,489 |
| Automobile rentals (w/o drivers) | 3,319 |
| 2. Gasoline service stations | 28,600 |
| 3. Hotels and other lodging places | 73,470 |
| 4. Eating and drinking places | 118,106 |
| 5. Gift, novelty, and souvenir shops | 2,716 |

During the year 1972, expenditures by travelers in Florida amounted to 3,382.7 millions of dollars. The tourism impact factor for Florida, defined as per capita tourist expenditures as a percentage of per capita, personal income amounted to 4.23. The tourism proportion factor, defined as travel expenditures as a percentage of gross state product for Florida amounted to 3.87. This travelers' expenditures figure was published in

the Florida Statistical Abstract with the permission of the source organization, the U. S. Travel Data Center, 1100 Connecticut Avenue, N.W., Washington, D. C. 20036.

c. Louisiana

Selected portions of the economic activity for Louisiana are presented in Table 50. During 1970 approximately 40 percent of the manufacturing employment in southern Louisiana was in the durable goods industries, and approximately 60 percent of the employment in manufacturing was in the nondurable goods category.

Approximately 10 percent of the manufacturing employment in southern Louisiana during 1970 occurred in the metal industries, and almost 19 percent of the total manufacturing employment was in the category of chemicals and allied products.

Employment in retail trade in the city of New Orleans, and including a portion of the adjacent area of the State of Mississippi, amounted to approximately 76 thousand persons during 1967, and an additional 31 thousand were employed in wholesale trade in the same area.

During January, 1976, the index of employment in manufacturing in Louisiana was 108.4, compared to 109.9 during the same period in January, 1974. Employment in the category of construction increased from an index of 102.0 during January, 1974 to 110.5 during January, 1975 (Federal Reserve Bank of Atlanta, 1975).

In the New Orleans SMSA including Orleans, Jefferson, St. Bernard, and St. Tammany parishes, the civilian labor force during the month of

Table 50. Economic Activity for Louisiana

| | 1962 | 1972 |
|---|---|---|
| Per capita personal income | $1,764 | $ 3,543 |
| Total personal income | $5,901 | $13,179 (million) |
| Total cash farm income | $ 448 | $ 882 (million) |
| Cash farm receipts from crops | $ 264 | $ 507 (million) |
| Cash farm receipts from livestock and products | $ 164 | $ 324 (million) |
| Petroleum production | 477 | 896 (mil. bbls.) |
| Value of construction | $ 659 | $ 2,036 (million) |
| Manufacturing employment | 139 | 179 (thousand) |
| Construction employment | 53 | 85 (thousand) |

February, 1975 amounted to 427,600 persons, compared to 412,300 persons during February, 1974. During February, 1975, employment amounted to 388,900 persons, an increase of 15,300 persons over the same month the previous year. However, comparing the unemployment for February, 1975, with February, 1974, reveals that unemployment also increased. During February, 1975, 38,700 persons were classified as unemployed, an increase of 7,800 over the 30,900 persons classified as unemployed during February, 1974.

d. Mississippi

Selected portions of the economic activity for Mississippi are presented in Table 51. During 1970, approximately 55 percent of the manufacturing employment in the southern half of the state occurred in the manufacture of durable goods. The balance of employment within the category of manufacturing was in the production of nondurable goods category were engaged in the production of textiles and fabricated textile products.

During the month of January, 1975, the civilian labor force in Mississippi amounted to 905,800 persons, 7,500 less than during December, 1974, but 17,400 more than during January, 1974. The number of employed during the month of January, 1975, amounted to 850,000 persons, approximately 2,100 less than a year earlier. Unemployment

Table 51. Economic Activity in Mississippi

| | 1962 | 1972 |
|---|---|---|
| Per capita personal income | $1,328 | $ 3,137 |
| Total personal income | $2,978 | $ 7,099 (million) |
| Total cash farm income | $ 704 | $ 1,210 (million) |
| Cash farm receipts from crops | $ 396 | $ 535 (million) |
| Cash farm receipts from livestock and products | $ 290 | $ 550 (million) |
| Farm population in southern Mississippi | 3,359 | 5,869 2/ |
| Petroleum production | 55,713 | 61,075 (thou. bbls.) |
| Value added: manufactured goods | $ 849 | $ 2,237 1/ (million) |
| Value of construction | $ 267 | $ 885 (million) |
| Manufacturing employment | 128 | 205 (thousand) |
| Construction employment | 23 | 35 (thousand) |

1/ 1971
2/ Increased farm population in the Gulf truck farm region.

during January, 1975, amounted to 55,800, an increase of 19,500 over the January, 1974, figure.

Part of the increase in unemployment was due to seasonal factors, but cutbacks at many plants in the state swelled the unemployed ranks. The figures for December, 1974, and January, 1975, were affected by a work stoppage, a short cotton crop, and post-Christmas lay-offs. During 1974, only three of the state's nineteen manufacturing industries reported more employment this year than last; non-electric machinery, transportation equipment and food.

For those workers still employed, work weeks have been shortened. As inventories built up, many employers cut back to a three or four day work week in an effort to avoid laying workers off.

Across the state, employment increases, compared to the same month a year ago, occurred in mining, transportation, communications and public utilities, wholesale and retail trade, finance, insurance, and real estate, services and government.

In the southern portion of the state, the data reported from four employment offices, serving eleven counties, for the month of March, 1975, indicate a total of 157,750 employed persons, an increase of approximately 3,000 over the level of March, 1974. However, the number of unemployed increased from 5,690 during March, 1974, to 9,490 during March, 1975, an increase of 3,800 during the year (Table 52).

Table 52. Employment in Mississippi; 1974-1975

| Location | Total Employed March, 1974 | Total Employed March, 1975 | Total Unemployed March, 1974 | Total Unemployed March, 1975 |
|---|---|---|---|---|
| Biloxi and Gulfport | 51,800 | 53,480 | 2,240 | 3,690 |
| Hattiesburg | 40,430 | 40,160 | 1,300 | 2,460 |
| Pascagoula | 52,680 | 54,370 | 1,700 | 2,460 |
| Picayune | 9,830 | 9,740 | 450 | 880 |
| Totals | 154,740 | 157,750 | 5,690 | 9,490 |

Source: Manpower News, Mississippi State Employment Service.

e. Texas

Selected portions of the economic activity for Texas are presented in Table 53.

Table 53. Economic Activity in Texas

| | 1962 | 1972 |
|---|---|---|
| Per capita personal income | $ 2,027 | $ 4,045 |
| Total personal income | $20,518 | $47,121 (million) |
| Total cash farm income | $ 2,575 | $ 3,722 1/ (million) |
| Cash farm receipts from crops | $ 1,352 | $ 1,132 (million) |
| Cash farm receipts from livestock and products | $ 1,075 | $ 2,122 (million) |
| Petroleum production | 943 | 1,301 2/ (mil. bbls.) |
| Value of construction | 1,132 | 1,751 1/ |
| Manufacturing employment | 497 | 741 (thousand) |
| Construction employment | --- | 238 (thousand) |

1/ 1971
2/ Crude production appears to have peaked during 1974.

During 1972, approximately 398,000 workers were employed in the manufacture of durable goods, and approximately 343,000 were employed in manufacturing nondurable goods.

Employment in wholesale and retail trade amounted to approximately 951,000 persons in 1972. Employment in water transportation amounted to approximately 21,000, and employment in pipeline transportation amounted to approximately 5,000 during 1972.

The recent changes in the economy of the State of Texas have been summarized by Stockton (1975).

Comparison of business activity in Texas with measures of business activity on the national level indicated that the Texas economy has shown much greater resistance to the depressing forces present within the national economy than has the nation as a whole; however, the Texas economy did not maintain a normal growth rate.

The most depressed segment of the Texas economy has been the building industry. For the first two months of 1975 the amount of building construction authorized declined 29 percent from the same period in 1974; however, much of the construction authorized in earlier periods was still providing jobs and the employment in contract construction was 1.7 percent higher in February, 1975, than in February, 1974. However, the decline in authorized construction may indicate future unemployment as workers are released when current projects are completed. The number of building permits issued for repairs, additions and alterations has increased.

Employment in the manufacture of durable goods has declined

from approximately 451,000 during February, 1974, to about 437,000 during February, 1975, and employment in the manufacture of non-durable goods has decreased from 364,000 to 350,000 workers.

The percentages of unemployed persons reported from selected locations along the Texas coast during the month of February, 1975, are summarized below.

| Location | Unemployed February, 1975 | Change From February, 1974 |
|---|---|---|
| Beaumont-Port Arthur-Orange | 6.7% | 16% |
| Brownsville-Harlingen-San Benito | 10.2% | 32% |
| Corpus Christi | 6.3% | 11% |
| Galveston-Texas City | 4.7% | 9% |
| Houston | 5.1% | 31% |

The influence of the increased level of petroleum exploration activity both within the state, and in other areas, was reflected in various sectors of the Texas economy. "Employment in machinery manufacture (excluding electrical) was 8.0 percent higher in February, 1975, than in February, 1974, reflecting largely the increase of 17.5 percent in employment in oil field machinery manufacture. This is the result of the recent increase in oil exploration. Employment in the manufacture of instruments and related products, which also reflects the effects of oil exploration, increased 5.1 percent over the past year" (Stockton, 1975).

Employment within Texas in activities related to the oil and gas production and processing industries has also been affected during the past year as discussed by Stockton (1975).

> "Crude oil production in February, 1975, decreased 7.0 percent compared with February, 1974, as the Texas fields have apparently reached their full capacity for the present. But higher prices of crude oil can be expected to continue; they will undoubtedly support exploration and will add substantially to the economy. Texas employment in oil and gas extraction in February, 1975, showed an increase of 10.5 percent over the February, 1974, figure, in spite of the fact that the total production of crude oil declined over the same period. The decline in gasoline consumption over the past year is reflected in the 15.1 percent decline of employment in refining. Some of the decline in refining has been offset by increased activity in chemicals, which are mainly petrochemicals. In spite of the decline in refining, oil and gas continue to be among the major supporting factors for the Texas economy."

2. Population and Employment

During September, 1972, the U. S. Water Resources Council published the 1972 OBERS projections of economic activity in the United States. These projections consist of historical and projected data incorporating population, employment and income and earnings information classified by state and by region. The 1972 projections utilized population projections published by the Census Bureau, and

were based on the Series C fertility rates. Recently, the projections of economic activity in the various OBERS Economic Areas based on the Series E fertility rates have become available. Projections based on Series E forecast a lower level of population in future years. The following projections for BEA areas located adjacent to the Gulf of Mexico were obtained from the Series E projections.

In considering the coastal portions of the states bordering the Gulf of Mexico, during the period 1950 to 1970, the percentage increase in population and employment in all three regions was greater than the percentage increase in national population and employment. During the period 1970 to 1990, population and employment in the eastern and western Gulf of Mexico regions is expected to increase at greater percentage rates that the national percentage rates.

Tables 54 & 55 contain population, employment, and per capita income data, both historical and projected, for the BEA areas included within the various regions adjacent to the Gulf of Mexico.

Table 54. Regional Population and Employment

| Region | 1950 | 1970 | % Change 1950-1970 | 1990 | % Change 1970-1990 |
|---|---|---|---|---|---|
| Eastern Gulf BEA Areas: 037, 038, 039, & 137 | | | | | |
| Population | 1,698,259 | 3,267,717 | 92.4% | 4,732,900 | 44.8% |
| Employment | 600,384 | 1,138,419 | 89.6% | 1,704,200 | 49.7% |
| Central Gulf BEA Areas: 138 and 139 | | | | | |
| Population | 2,070,014 | 2,900,230 | 40.1% | 3,142,900 | 8.4% |
| Employment | 692,826 | 963,028 | 39.0% | 1,186,500 | 23.2% |
| Western Gulf BEA Areas: 140, 141, 142, 143, & 144 | | | | | |
| Population | 3,140,093 | 4,883,064 | 55.5% | 6,078,000 | 24.5% |
| Employment | 1,133,386 | 1,816,283 | 60.3% | 2,535,700 | 39.6% |
| United States | | | | | |
| Population | 151,325,798 | 203,235,298 | 34.3% | 246,039,000 | 20.7% |
| Employment | 57,474,912 | 79,306,527 | 38.0% | 106,388,000 | 34.1% |

Source: OBERS 1972 E Projections

Table 55. Population, Employment, and Per Capita Income, Historical and Projected 1950-2000 (1972-E, OBERS Projections, Bureau of Economic Analysis)

| BEA | Economic Area | 1950 | 1970 | Percent Change 1950-1970 | 1980 | 1990 | 2000 |
|---|---|---|---|---|---|---|---|
| 037 | St. Petersburg, Fla. | | | | | | |
| | Population | 706,870 | 1,812,456 | 156.4% | 2,440,100 | 2,968,100 | 3,409,900 |
| | Per Capita Income[1/] | 1,750 | 2,997 | 71.3% | 4,200 | 5,500 | 7,300 |
| | Total Employment | 256,872 | 615,382 | 139.6% | 851,300 | 997,500 | 1,141,400 |
| 038 | Tallahassee, Fla. | | | | | | |
| | Population | 259,490 | 345,749 | 33.2% | 414,800 | 487,000 | 542,500 |
| | Per Capita Income | 1,124 | 2,513 | 123.6% | 3,500 | 4,700 | 6,400 |
| | Total Employment | 87,909 | 127,558 | 45.1% | 168,000 | 199,400 | 231,100 |
| 039 | Pensacola, Fla. | | | | | | |
| | Population | 207,346 | 384,529 | 85.5% | 394,700 | 437,800 | 465,200 |
| | Per Capita Income | 1,527 | 2,718 | 78.0% | 3,700 | 4,800 | 6,500 |
| | Total Employment | 70,961 | 143,304 | 101.9% | 161,000 | 178,800 | 196,700 |
| 137 | Mobile, Ala. | | | | | | |
| | Population | 524,553 | 724,983 | 38.2% | 768,400 | 840,000 | 870,900 |
| | Per Capita Income | 1,435 | 2,488 | 73.4% | 3,500 | 4,600 | 6,300 |
| | Total Employment | 184,642 | 252,175 | 36.6% | 296,900 | 328,500 | 355,000 |

(continued)

Table 55 (continued) Population, Employment, and Per Capita Income, Historical and Projected 1950-2000 (1972-E, OBERS Projections, Bureau of Economic Analysis

| BEA | Economic Area | 1950 | 1970 | Percent Change 1950-1970 | 1980 | 1990 | 2000 |
|---|---|---|---|---|---|---|---|
| 138 | New Orleans, La. | | | | | | |
| | Population | 1,535,505 | 2,149,598 | 40.0% | 2,284,200 | 2,440,000 | 2,528,600 |
| | Per Capita Income | 1,641 | 2,849 | 73.6% | 3,900 | 5,200 | 7,000 |
| | Total Employment | 530,342 | 717,945 | 35.4% | 854,000 | 928,900 | 1,012,500 |
| 139 | Lake Charles, La. | | | | | | |
| | Population | 534,509 | 750,632 | 40.4% | 695,800 | 702,900 | 685,400 |
| | Per Capita Income | 1,256 | 2,463 | 96.1% | 3,400 | 4,500 | 6,200 |
| | Total Employment | 162,484 | 245,083 | 50.8% | 251,400 | 257,600 | 263,800 |
| 140 | Beaumont-Port Arthur-Orange, Texas | | | | | | |
| | Population | 299,857 | 396,723 | 32.3% | 432,800 | 484,900 | 520,100 |
| | Per Capita Income | 1,820 | 3,105 | 70.6% | 4,200 | 5,500 | 7,400 |
| | Total Employment | 106,986 | 140,677 | 31.5% | 168,800 | 192,300 | 215,800 |
| 141 | Houston, Texas | | | | | | |
| | Population | 1,257,035 | 2,374,842 | 88.9% | 2,832,400 | 3,362,700 | 3,780,400 |
| | Per Capita Income | 2,308 | 3,519 | 52.5% | 4,700 | 6,100 | 8,000 |
| | Total Employment | 485,199 | 945,995 | 95.0% | 1,244,700 | 1,474,400 | 1,701,900 |

(continued)

Table 55 (continued) Population, Employment, and Per Capita Income, Historical and Projected 1950-2000 (1972-E, OBERS Projections, Bureau of Economic Analysis

| BEA | Economic Area | 1950 | 1970 | Percent Change 1950-1970 | 1980 | 1990 | 2000 |
|---|---|---|---|---|---|---|---|
| 142 | San Antonio, Texas | | | | | | |
| | Population | 853,013 | 1,235,581 | 44.8% | 1,245,900 | 1,352,000 | 1,417,200 |
| | Per Capita Income | 1,674 | 2,770 | 65.5% | 3,800 | 5,000 | 6,800 |
| | Total Employment | 309,559 | 451,412 | 45.8% | 503,500 | 550,300 | 598,300 |
| 143 | Corpus Christi, Texas | | | | | | |
| | Population | 407,011 | 518,920 | 27.5% | 515,000 | 534,600 | 544,000 |
| | Per Capita Income | 1,525 | 2,651 | 73.8% | 3,700 | 4,800 | 6,600 |
| | Total Employment | 132,095 | 176,319 | 33.5% | 195,100 | 204,300 | 217,400 |
| 144 | McAllen-Pharr-Edinburg, Texas | | | | | | |
| | Population | 323,177 | 356,998 | 10.5% | 346,000 | 343,800 | 336,300 |
| | Per Capita Income | 1,111 | 1,884 | 69.6% | 2,800 | 3,700 | 5,200 |
| | Total Employment | 99,547 | 101,880 | 2.3% | 113,800 | 114,400 | 118,100 |

1/ Per Capita Income is expressed in 1967 dollars.

The coastal portion of Louisiana and part of Mississippi, comprising the central Gulf of Mexico region, is included with BEA economic areas 138 and 193.

The coastal portions of Alabama, a portion of the Mississippi coastal area, and the major portion of the western coastal area of Florida are included in BEA economic areas 037, 038, 039 and 137. This area is referred to as the eastern Gulf of Mexico region.

The coastal portions of Texas are included within BEA areas 140, 141, 143 and 144, and are included within the western Gulf of Mexico region.

A comparison of the population, employment, and personal income of the inhabitants of these regions with the total United States population, employment, and personal income is shown in Table 56.

Table 56. Population and Employment By Income Regions Compared to Total U. S., 1970

| | Total U. S. | Gulf of Mexico Western | Gulf of Mexico Central | Gulf of Mexico Eastern |
|---|---|---|---|---|
| Total Population | 203,857,864 | 4,883,064 | 2,900,230 | 3,267,717 |
| % of U. S. | --- | 2.4% | 1.4% | 1.6% |
| Total Employment | 79,306,527 | 1,816,283 | 963,028 | 1,138,419 |
| % of U. S. | --- | 2.3% | 1.2% | 1.4% |
| Total Personal Income[1/] | $708,583,931 | $15,059,700 | $7,973,192 | $9,150,233 |
| % of U. S. | --- | 2.1% | 1.1% | 1.3% |

1/ Total personal income in thousands of 1967 dollars

Perhaps the most significant relationship revealed in Table 56 is that in all three regions employment and personal income is a smaller percentage of national employment and personal income than is the percentage of population of the total U. S. population.

A significant trend that has been present during the last decade in the economic climate of the states bordering the Gulf of Mexico has been the decline in farm employment and the increase in employment in manufacturing and such non-manufacturing categories as mining, construction, transportation and services.

Table 57, based on data obtained from the 1972-E OBERS projections, presents the earnings data for selected industries in the Gulf of Mexico coastal regions during 1970.

Table 57. Total Earnings[1/] by Selected Industries, 1970

| Industry | Total U.S. | Gulf of Mexico Western | Gulf of Mexico Central | Gulf of Mexico Eastern |
|---|---|---|---|---|
| Agriculture, forest & fisheries | 19,640,721 | 408,029 | 226,622 | 287,381 |
| Mining | 5,647,503 | 448,490 | 407,977 | 39,610 |
| Manufacturing | 156,291,199 | 2,415,108 | 1,137,201 | 1,216,005 |
| Services | 85,077,671 | 1,792,200 | 884,246 | 1,024,935 |
| Government | 99,310,475 | 2,350,310 | 1,073,445 | 1,518,090 |

1/ Total earnings in thousands; 1967 dollars

The BEA economic regions included within the classification of western, central, and eastern Gulf of Mexico form only a portion of the various states bordering the Gulf of Mexico.

3. Agriculture

During the year 1950, 7,047,625 persons were employed in agriculture in the United States. By the year 1970, 2,813,971 persons were employed in agriculture, and the projected employment in the year 1990 amounted to 2,003,000 persons. The total earnings from agriculture amounted to 19,348,268 thousands of 1967 dollars during 1970, and are projected to amount to 22,562,000 thousands of 1967 dollars in 1990. These projections were contained in the 1972 OBERS projections (U. S. Water Resources Council, 1974) based on the Series E population projections developed by the Bureau of the Census. The OBERS projections do not reflect the current energy problem, changes in agricultural exports, or changes in conservation and environmental activities.

The total value of agricultural products within the states bordering the Gulf of Mexico was projected to increase during the period 1959 to 1980, according to the OBERS projections (Table 58 ). The total land in farms was projected to decrease in all of the five states during the same period of time. The decrease noted in the total land in farms was in accord with the projection for the entire United States (Table 59).

Table 58. Value of Agricultural Production[1/]

| State | 1959 | 1980 |
|---|---|---|
| Alabama | | |
| Total crops | 213,098.1 | 195,912.9 |
| Total livestock | 326,761.8 | 622,097.2 |
| Total state | 539,859.9 | 818,010.1 |
| Florida | | |
| Total crops | 424,121.5 | 778,633.1 |
| Total livestock | 213,215.4 | 353,662.7 |
| Total state | 637,336.9 | 1,132,295.8 |
| Louisiana | | |
| Total crops | 246,071.4 | 428,392.0 |
| Total livestock | 171,141.9 | 276,147.3 |
| Total state | 417,213.3 | 704,539.3 |
| Mississippi | | |
| Total crops | 353,252.8 | 474,373.3 |
| Total livestock | 292,562.7 | 528,887.1 |
| Total state | 645,815.5 | 1,003,260.4 |
| Texas | | |
| Total crops | 1,071,387.1 | 1,368,388.7 |
| Total livestock | 949,329.8 | 1,479,583.5 |
| Total state | 2,020,716.8 | 2,847,972.2 |

1/ All values are shown in 1967 prices.

Table 59. Land in Farms (thousand acres)

| | 1959 | 1980 |
|---|---|---|
| United States | | |
| Cropland, harvested | 311,285.2 | 292,242.6 |
| Cropland, not harvested | 136,278.5 | 165,843.4 |
| Forest and woodland | 163,684.3 | 105,231.8 |
| Pasture, range, other | 508,909.8 | 481,566.3 |
| Total land in farms | 1,120,157.8 | 1,044,884.1 |
| Alabama | | |
| Cropland, harvested | 3,715.3 | 2,457.7 |
| Cropland, not harvested | 2,312.7 | 3,607.0 |
| Forest and woodland | 7,776.9 | 5,003.0 |
| Pasture, range, other | 2,737.9 | 2,364.3 |
| Total land in farms | 16,542.8 | 13,432.0 |
| Florida | | |
| Cropland, harvested | 1,881.9 | 2,329.8 |
| Cropland, not harvested | 1,519.0 | 1,341.3 |
| Forest and woodland | 6,732.7 | 3,439.3 |
| Pasture, range, other | 5,102.9 | 6,127.3 |
| Total land in farms | 15,236.5 | 13,237.7 |
| Louisiana | | |
| Cropland, harvested | 2,425.9 | 3,747.5 |
| Cropland, not harvested | 2,481.1 | 2,351.7 |
| Forest and woodland | 3,212.9 | 1,634.0 |
| Pasture, range, other | 2,227.4 | 1,868.6 |
| Total land in farms | 10,347.3 | 9,601.8 |
| Mississippi | | |
| Cropland, harvested | 4,564.3 | 4,942.3 |
| Cropland, not harvested | 2,528.4 | 3,511.0 |
| Forest and woodland | 7,611.9 | 4,645.2 |
| Pasture, range, other | 3,925.7 | 2,823.2 |
| Total land in farms | 18,630.3 | 15,921.7 |
| Texas | | |
| Cropland, harvested | 22,236.5 | 20,331.0 |
| Cropland, not harvested | 13,362.6 | 19,273.8 |
| Forest and woodland | 13,631.3 | 8,624.0 |
| Pasture, range, other | 93,987.1 | 93,388.5 |
| Total land in farms | 143,217.5 | 141,617.3 |

Source: OBERS Projections, Series E

Table 60. Total Earnings from Agriculture
(Thousands of 1967 Dollars)

| | 1969 | 1980 |
|---|---|---|
| Eastern Gulf of Mexico | | |
| BEA 037 | 232,103 1/ | 226,500 |
| BEA 038 | 36,522 | 41,700 |
| BEA 039 | 10,725 | 11,700 |
| BEA 137 | 28,766 | 32,800 |
| Total Eastern Gulf | 308,116 | 312,700 |
| Central Gulf of Mexico | | |
| BEA 138 | D 2/ | 118,400 |
| BEA 139 | D | 137,900 |
| Total Central Gulf | D | 256,300 |
| Western Gulf of Mexico | | |
| BEA 140 | 4,440 | 4,100 |
| BEA 141 | D | 94,000 |
| BEA 142 | 127,549 | 119,100 |
| BEA 143 | 87,322 | 81,400 |
| BEA 144 | D | 96,100 |
| Total Western Gulf | 219,311 (partial) | 394,700 |

1/ Thousands of 1967 dollars

2/ Deleted

Source: OBERS Projections, Series E, Population

During the period 1962 to 1972, the total workers on Texas farms decreased from 415,000 in 1962 to 275,000 in 1972. The total workers include both family workers and hired workers. The family workers decreased from 243,000 to 187,000, and the hired workers from 172,000 to 88,000 (A.H. Belo Co., 1973).

These changes in employment reflect post-war changes in Texas agriculture, also reflected in the increase in the average size of Texas farms and increases in the average value of land and buildings on farms and ranches.

The most notable change has been the mechanization of farming due to the increasing use of tractors, mechanical harvesters and other machinery in place of human and animal labor. The introduction and adoption of agricultural chemicals, improved plants and animals, irrigation and increased availability of off-the-farm services have also been significant factors in the change of Texas agriculture.

The pattern of decreasing farm employment was also evident in the other states bordering the Gulf of Mexico.

In Alabama, farm employment decreased from 138 thousands in 1962 to 82 thousands in 1972. Farm employment in Louisiana decreased from 144 thousands in 1962 to 73 thousands in 1972, and in Mississippi, farm employment decreased from 225 thousands in 1962 to 113 thousands in 1972. Although farm employment in Florida stood at 114 thousand in 1972, compared to 122 thousand in 1962, during the years 1968 and 1969, farm employment was 112 thousand, approximately two thousand

below the 1972 level (Federal Reserve Bank of Atlanta, 1975).

### 4. The Petroleum Industry in the Gulf of Mexico Area

Some further discussion of the petroleum industry of the states adjacent to the Gulf of Mexico is appropriate since crude petroleum and natural gas production developed as a result of exploration and production activity on the outer continental shelf will probably be a source of raw material for initial processing within the coastal portions of these states.

The production of oil and gas may be classified as a primary industry; the further processing of oil and gas in refineries, natural gasoline plants and petrochemical plants may be considered as secondary industries, and the increased development of tertiary industries may be expected to develop as a result of the economic activity undertaken by the primary and secondary industries.

The coastal region of the states bordering the Gulf, including both onshore and offshore areas, have been productive of oil and gas for many years. The production of these hydrocarbons has led to the extensive development of a system of production, transportation, refining and other manufacturing facilities based on the availability of crude and refined petroleum products in the region.

Oil and gas resources include substances classified as crude oil, condensate, natural gas and natural gas liquids. Crude oil is a mixture of hydrocarbons that exists as a liquid in the natural underground reservoir and continues to exist as a liquid on the surface at atmospheric pressure. Condensate is a substance that exists as

a gas in the natural underground reservoir and exists as a liquid under atmospheric conditions. Natural gas plant liquids are hydrocarbons extracted from streams of natural gas processed at plants. The American Petroleum Institute and American Gas Association statistical data include as crude oil small amounts of hydrocarbons recovered from oil well gas that exist as gases in the reservoir but become liquid at atmospheric pressure. All other liquids, including condensate, are reported as natural gas liquids.

a. Historical data of Gulf of Mexico OCS operations

In the FPC[1/] News, August 8, 1975, a tabulation of new well and completion activity on the Federal domain in the Gulf of Mexico was included in an article entitled Gas Supply Indicators, First Quarter. 1975.

| Year | Oil & Gas New Well Starts | Oil & Gas Well Competions | Zone Completions Producible Oil and Gas Zones | | |
|---|---|---|---|---|---|
| | | | Oil | Gas | Total |
| 1968 | 931 | 410 | 524 | 166 | 690 |
| 1969 | 826 | 363 | 448 | 125 | 573 |
| 1970 | 827 | 535 | 611 | 266 | 877 |
| 1971 | 806 | 379 | 357 | 240 | 597 |
| 1972 | 839 | 335 | 303 | 180 | 483 |
| 1973 | 816 | 418 | 302 | 288 | 590 |
| 1974 | 808 | 305 | 221 | 155 | 376 |

Although gas well footage drilled offshore increased 43.3 percent in the 1st quarter of 1975 over the same quarter last year, the exploratory gas well footage declined 11.5 percent. This decline was offset by the increase of 48.2 percent in developmental gas well footage. Almost three-fourths of the offshore exploratory drilling in this year's 1st quarter took place off of Texas, but over 95 percent of the offshore

1/ Federal Power Commission

developmental gas footage occurred off the Louisiana coast.

The number of acres held under active lease in the Gulf of Mexico has increased from 3.9 million acres in 1969 to 7.4 million acres as of March 31, 1975. Approximately 41 percent of the acreage held on March 31, 1975 was classified as included in producing leases, compared to 58 percent so classified in 1968.

The amounts of oil, condensate and gas that have been produced from Federal leases in the Gulf of Mexico are published in Outer Continental Shelf Statistics, U.S.G.S. June 1975.

The amounts of oil and gas produced from these leases is tabulated below.

Oil and Condensate (000 bbls)

| Year | Louisiana | Texas | Total |
|---|---|---|---|
| 1968 | 263,825 | 3,111 | 266,936 |
| 1969 | 300,159 | 2,760 | 302,919 |
| 1970 | 333,411 | 2,247 | 335,658 |
| 1971 | 385,760 | 1,685 | 387,445 |
| 1972 | 387,591 | 1,733 | 389,324 |
| 1973 | 374,197 | 1,618 | 375,815 |
| 1974 | 342,435 | 1,382 | 343,817 |

Natural Gas MMCF

| Year | Louisiana | Texas | Total |
|---|---|---|---|
| 1968 | 1,413,468 | 109,911 | 1,523,379 |
| 1969 | 1,822,544 | 127,097 | 1,949,641 |
| 1970 | 2,273,147 | 133,300 | 2,406,447 |
| 1971 | 2,634,014 | 127,358 | 2,761,372 |
| 1972 | 2,881,365 | 147,156 | 3,028,521 |
| 1973 | 3,055,628 | 148,674 | 3,204,302 |
| 1974 | 3,349,171 | 159,979 | 3,509,150 |

b. Crude oil,gas liquids, and natural gas reserves

The estimates of crude oil, gas liquids, and natural gas reserves in the five state area adjacent to the Gulf of Mexico as of January 1, 1974, are presented in Table 61.

Table 61. Estimated Crude Oil, Natural Gas Liquids, and Natural Gas Reserves. 1/

| State | Crude Oil Thousands of Barrels | Natural Gas Liquids Thousands of Barrels | Natural Gas MMCF |
|---|---|---|---|
| Alabama | 53,603 | 44,592 | 327,375 |
| Florida | 183,859 | 3,307 | 148,914 |
| Louisiana | 4,576,826 | 1,992,537 | 69,151,613 |
| Mississippi | 291,049 | 14,090 | 1,178,218 |
| Texas | 11,756,613 | 2,830,143 | 84,936,502 |
| Totals 2/ | 16,861,950 | 4,884,669 | 155,742,622 |

1/ American Petroleum Institute, et al (1975), estimates as of January 1, 1974.
2/ These totals represent approximately 48, 76, and 62 percent, respectively, of the total U. S. reserves as of January 1, 1974.

c. Crude petroleum production

During the year 1973, approximately 66 percent of the total U. S. production of crude petroleum occurred in the states of Alabama, Florida, Louisiana, Mississippi, and Texas.

The quantities produced in the coastal area of Louisiana and Texas, as well as the total production from Alabama, Florida, and Mississippi, are shown in Table 62.

A significant fact revealed by these statistics is a decline in the production of crude oil and condensate in this region. Production of crude petroleum in three of the five states in this area decreased between 1972 and 1973, reflecting the national trend. These decreases occurred in spite of an increase in the average value per barrel of oil. The increases recorded in the other two states were not sufficient to offset the decline in the area.

Recent production figures obtained from the November, 1974, Petroleum Statement Monthly (Table 63) indicate that the decline in offshore production was evident during the first eleven months of 1974.

d. Natural gas

The Minerals Yearbook (U. S. Department of the Interior, 1973b), provides statistical detail concerning the source and use of natural gas.

Natural gas produced in Texas during 1971 was used to satisfy the demand for gas by individuals and organizations within Texas and in other areas of the United States. During the year 1971, natural gas was also imported from, and exported to, Mexico. Some volumes

Table 62. Production, Producing Wells, Average Production Per Well

| | 1973 | 1972 |
|---|---|---|
| Alabama | | |
| Crude Petroleum Production[1/] | 11,677 | 9,934 |
| No. Producing Oil Wells | 586 | 544 |
| Average Production Per Well[2/] | 56.6 | 49.3 |
| Average Value Per Barrel | \$3.58 | \$3.07 |
| Florida | | |
| Crude Petroleum Production | 32,695 | 16,897 |
| No. Producing Oil Wells | 147 | 142 |
| Average Production Per Well | 619.9 | 419.7 |
| Average Value Per Barrel | \$4.59 | \$3.18 |
| Louisiana (Gulf Coast) | | |
| Crude Petroleum Production | 791,760 | 847,554 |
| No. Producing Oil Wells | 13,086 | 13,624 |
| Average Production Per Well | 162.4 | 167.7 |
| Average Value Per Barrel | \$4.00 | \$3.59 |
| Mississippi | | |
| Crude Petroleum Production | 56,102 | 61,100 |
| No. Producing Oil Wells | 2,901 | 3,195 |
| Average Production Per Well | 50.4 | 53.0 |
| Average Value Per Barrel | \$3.81 | \$3.15 |
| Texas (Gulf Coast) | | |
| Crude Petroleum Production | 253,296 | 260,607 |
| No. Producing Oil Wells | 14,199 | 15,576 |
| Average Production Per Well | 46.6 | 44.8 |
| Average Value Per Barrel | \$4.11 | \$3.73 |
| United States (Total) | | |
| Crude Petroleum Production | 3,360,903 | 3,455,368 |
| No. Producing Oil Wells | 497,378 | 508,443 |
| Average Production Per Well | 18.3 | 18.4 |
| Average Value Per Barrel | \$3.89 | \$3.39 |

1/ Thousands of barrels
2/ Average production per well per day (barrels)

Source: U. S. Department of the Interior (1974k).

Table 63.

Crude Oil and Condensate Production for Texas and Louisiana Gulf Coastal Areas

| | 1972 | 1973 | Jan.-Nov. 1974 1/ | Jan.-Nov. 1973 |
|---|---|---|---|---|
| Louisiana Gulf Coast | | | | |
| Onshore | 401,639 2/ | 364,976 | | |
| Offshore | | | | |
| State | 58,327 | 53,298 | 71,587 | 50,745 |
| Federal | 387,594 | 373,486 | 299,316 | 349,547 |
| Total Offshore | 445,915 | 426,784 | 370,903 | 400,292 |
| Total Louisiana Gulf Coast | 847,554 | 791,760 | | |
| Texas Gulf Coast | | | | |
| Onshore | 258,134 | 251,899 | | |
| Offshore | | | | |
| State | 740 | 699 | 543 | 627 |
| Federal | 1,733 | 728 | 460 | 676 |
| Total Offshore | 2,473 | 1,397 | 1,003 | 1,303 |
| Total Texas Gulf Coast | 260,607 | 253,296 | | |

1/ January through November, inclusive.
2/ All figures are shown in thousands of barrels.
Source: U. S. Department of the Interior, 1974i.

of natural gas produced in other states were transported into Texas during the year.

Approximately 90 percent of the natural gas withdrawn from Texas wells was marketed. The balance was used for repressuring and a small amount was vented to the atmosphere or flared. The marketed production of Texas natural gas, augmented by volumes obtained from other areas, was delivered to interstate pipelines for transmission to other areas, consumed in Texas or added to storage. Some amounts of gas were lost in transmission. Approximately 51 percent of the total Texas receipts of natural gas were consumed in Texas.

Some of this gas was used for lease and plant fuel and pipeline fuel, but approximately 72 percent was delivered to consumers, including residential and commercial users, electric utilities and industrial establishments. The industrial uses of the natural gas included fuel for refining operations, feedstock for the chemical industry and as material for the manufacture of carbon black.

During the year 1973, the total marketed production of natural gas in the United States amounted to 22,648 billion cubic feet, an increase of 0.5 percent over the 1972 level. The marketed production in the states of Alabama, Florida, Louisiana, Mississippi, and Texas amounted to 16,901 billion cubic feet of this total, or approximately 75 percent of the total marketed production.

Net deliveries of natural gas to interstate pipelines during 1973 amounted to approximately 5,906 billion cubic feet from Louisiana and

3,391 billion cubic feet from Texas. Consumption of natural gas in the five state region amounted to approximately 8,206 billion cubic feet during 1973, approximately 36 percent of the total U. S. consumption during the year (USDI, 1973e).

The number of producing gas and condensate wells located in the five state area increased from 33,096 to 34,621 between December, 1972 to 1973.

The FPC News (May 10, 1973), in a review of aspects of the natural gas supply in the United States, remarked on the recovery of gas well drilling activity that began in 1972 and continued during 1973 until capacity bottlenecks occurred toward the end of the year. The review continued an analysis of the current supply situation. "In contrast, the shortage of gas supply for ultimate consumers became more acute during 1973. For the past three years both marketed production of natural gas and producer sales to interstate pipelines have fluctuated within a very narrow range. Between 1972 and 1973 marketed production declined by 0.3 percent and producer sales (FPC Form 11 reports) declined by 2.9 percent. In the previous year there were increases of 0.2 percent in marketed production and 1.3 percent in producer sales. It is thus apparent that the new reserves that have become available as a result of increased gas well drilling have not been sufficient to prevent a further worsening of the national gas shortage. During the past year or two, some pipelines were unable to acquire enough new reserves to offset the declining production from old wells, let alone meet the obvious need of all

pipelines for more gas to serve the increased demand created by growth in the economy."

During the year 1973, approximately 466 million barrels of natural gas liquids were recovered at natural gas processing plants in Louisiana, Mississippi, Alabama, and Texas compared to approximately 471 million barrels recovered during 1972 (Table 64).

Table 64. Natural Gas Production and Consumption[1]

| | 1973 | 1972 |
|---|---|---|
| Gross Withdrawals | | |
| Alabama | 13,161[2] | 4,610 |
| Florida | 33,857 | 15,805 |
| Louisiana | 8,491,194 | 8,159,763 |
| Mississippi | 117,761 | 119,697 |
| Texas | 9,289,945 | 9,550,469 |
| Total | 17,945,918 | 17,850,344 |
| Marketed Production | | |
| Alabama | 11,271 | 3,644 |
| Florida | 33,857 | 15,521 |
| Louisiana | 8,242,423 | 7,972,678 |
| Mississippi | 99,706 | 103,989 |
| Texas | 8,513,850 | 8,657,840 |
| Total | 16,901,107 | 16,753,672 |
| Consumption | | |
| Alabama | 272,267 | 278,710 |
| Florida | 314,384 | 301,121 |
| Louisiana | 2,216,692 | 2,137,729 |
| Mississippi | 314,870 | 379,044 |
| Texas | 5,087,521 | 4,882,741 |
| Total | 8,205,734 | 7,979,345 |
| Net Deliveries to Interstate Pipelines | | |
| Alabama | -259,033 | -281,335 |
| Florida | -282,070 | -287,250 |
| Louisiana | +5,905,857 | +5,822,848 |
| Mississippi | -215,225 | -360,298 |
| Texas | +3,390,531 | +3,742,066 |
| Total | 8,540,060 | 8,636,031 |

1/ Source: U. S. Department of the Interior (1973e), Minerals Yearbook
2/ Figures in million cubic feet

## 5. Petroleum Refining and Petrochemicals in the Coastal Zone

On January 1, 1974, the crude oil capacity of the operating petroleum refineries in the United States amounted to 14,220,316 barrels per calendar day. An additional 232,800 BCD of refining capacity was located in Puerto Rico and the combined crude oil capacity in these operating refineries amounted to 14,453,116 barrels per calendar day. The total operating refinery capacity in the refining districts along the coast of the Gulf of Mexico amounted to 5,211,496 BCD or approximately thirty-six percent of the total U. S. capacity (Table 65).

Additional crude oil refining capacity amounting to 373,450 barrels per day was under construction in the coastal area of the Gulf of Mexico. This capacity amounts to approximately twenty-eight percent of the capacity under construction in the United States (Table 66).

Comments concerning the refining and petrochemical industries in the various states, pertaining to the existing industrial development, follow.

### a. Petroleum refining industry of Texas

As of January 1, 1974, according to the annual refining survey published in the Oil and Gas Journal (April 1, 1974), there were twenty-four operating petroleum refineries in the Texas coastal region with a combined capacity of more than three million barrels per calendar day.

Table 65. Operating Petroleum Refineries (January 1, 1974)
Gulf of Mexico Region
Bureau of Mines Refining Districts

| Operator | Location | Crude Capacity B/D[1/] |
|---|---|---|
| Texas Gulf Coast Refining District | | |
| American Petrofina | Port Arthur | 84,000 |
| Amoco Oil | Texas City | 333,000 |
| Atlantic Richfield | Houston | 213,000 |
| Champlin Refining | Corpus Christi | 62,186 |
| Charter International | Houston | 70,000 |
| Coastal States Petrochemical | Corpus Christi | 135,000 |
| Crown Central Petroleum | Pasadena | 100,000 |
| Eddy Refining | Houston | 2,160 |
| Exxon | Baytown | 400,000 |
| Gulf | Port Arthur | 312,100 |
| Marathon | Texas City | 61,000 |
| Mobil | Beaumont | 335,000 |
| Monsanto | Alvin | 8,500 |
| Phillips | Sweeny | 85,000 |
| Quintana Howell | Corpus Christi | 12,500 |
| Shell | Deer Park | 294,000 |
| South Hampton | Silsbee | 5,600 |
| Southwestern O & R | Corpus Christi | 105,000 |
| Sun | Corpus Christi | 57,000 |
| Texaco | Port Arthur | 406,000 |
| Texaco | Port Neches | 47,000 |
| Texas City Refining | Texas City | 60,000 |
| Union Oil of California | Nederland | 116,000 |
| Union Texas Petroleum | Winnie | 9,400 |
| Sub Total (Texas Gulf Coast) | | 3,313,446 |
| Louisiana Gulf Coast Refining District | | |
| Alabama | | |
| Alabama Refining | Theodore | 15,000 |
| Louisiana | | |
| Canal Refining | Church Point | 3,500 |
| Cities Service | Lake Charles | 268,000 |

(continued)

Table 65 (continued). Operating Petroleum Refineries (January 1, 1974)
Gulf of Mexico Region
Bureau of Mines Refining Districts

| Operator | Location | Crude Capacity B/D[1/] |
|---|---|---|
| Louisiana (continued) | | |
| Continental Oil | Egan | 15,000 |
| Continental | Westlake | 83,000 |
| Evangeline Refining | Jennings | 4,000 |
| Exxon | Baton Rouge | 445,000 |
| Good Hope Refineries | Good Hope | 29,450 |
| Gulf Oil | Belle Chasse | 180,400 |
| Gulf Oil | Venice | 28,700 |
| La Jet | St. James | 11,000 |
| Murphy Oil | Meraux | 92,500 |
| Shell | Norco | 240,000 |
| Tenneco | Chalmette | 97,500 |
| Texaco | Convent | 140,000 |
| Sub Total Louisiana | | 1,638,050 |
| Mississippi | | |
| Standard Oil Company (Kentucky) | Pascagoula | 240,000 |
| Sub Total (Louisiana Gulf Coast) | | 1,893,050 |
| East Coast Refining District | | |
| Florida | | |
| Seminole Asphalt Refining | St. Marks | 5,000 |
| Total Gulf of Mexico | | 5,211,496 B/D[1/] |

1/ B/D = barrels per day

Table 66. Additional Refining Capacity Under Construction on January 1, 1974

| Operator | Location | Additional Crude Capacity B/D[1/] |
|---|---|---|
| Texas Gulf Coast Refining District | | |
| Eddy Refining | Houston | 3,250 |
| Exxon | Baytown | 240,000 |
| Pioneer Refining | Nixon | 2,000 |
| Quintana Howell | Corpus Christi | 30,000 |
| Saber Petroleum | Corpus Christi | 2,500 |
| South Hampton | Silsbee | 24,000 |
| Texas City Refining | Texas City | 16,200 |
| Sub Total (Texas Gulf Coast) | | 317,950 B/D[1/] |
| Louisiana Gulf Coast Refining District | | |
| Alabama | | |
| Alabama Refining | Theodore | 2,500 |
| Louisiana | | |
| Exxon | Baton Rouge | 13,000 |
| Mississippi | | |
| Standard Oil Company (Kentucky) | Pascagoula | 40,000 |
| Sub Total (Louisiana Gulf Coast) | | 55,500 |
| Total Gulf of Mexico | | 373,450 B/D[1/] |

1/ B/D = barrels per day

The Texas Gulf coast refining district is the largest domestic refining district, measured in crude oil throughput capacity, and accounted for approximately twenty-three percent of the total operating crude oil throughput capacity of the United States (including Puerto Rice) (USDI, 1973f). The Texas Gulf coast refining capacity has ranged from twenty-two to twenty-four percent of the total U. S. refining capacity since the year 1962.

During the period 1962 to 1973, the daily crude oil capacity in the Texas Gulf coast district increased by 846,400 BCD, an increase of approximately thirty-nine percent over the 1962 operating capacity. The raw material received at refineries in the Texas Gulf coast refining district includes crude oil from domestic and foreign sources, natural gas liquids and other hydrocarbons. The products produced by refineries include gasoline and other fuels, lubricating oils, wax, coke, asphalt and feedstocks for petrochemical plants.

Refineries in Texas receive crude oil from other states for processing, and some of the crude oil produced in Texas is shipped to other states for refining.

During the year 1973, a total of 1,174 billion barrels were received at refineries in Texas. Approximately 1,045 billion barrels were obtained from sources within the United States, and an additional 128.8 million barrels were obtained from foreign sources. This level of imports is approximately equal to 350 thousands of barrels per day (USDI, 1974d).

Since approximately eighty-seven percent of the operating crude oil refining capacity of Texas is located in the Texas Gulf coast district, the following statement referring to the total Texas refining industry is applicable to the Gulf coast area. The data was obtained from a paper prepared by the Office of Information Services on January 2, 1974.

The importance of the petroleum refining industry to the Texas economy is partially demonstrated by the dollar value of sales, employment and household income generated directly by its operations. In 1972, the industry's total sales f.o.b. the refinery were $7.7 billion. The industry employed approximately 33,700 workers and paid an estimated $481 million to Texas households in wages, salaries and other payments. In addition, the petroleum refining industry provides inputs for production processes in many other industries-- most notably the petrochemical industry. It is estimated that approximately seven percent or $577 million of the Texas refineries' production was used by the petrochemical industry in 1972. The total production of the petrochemical industry in Texas in 1972 was estimated at $5.8 billion f.o.b. the plant.

b. Petrochemical industry

The importance of the chemical industry to Texas was recently evaluated by Ryan (1973). Chemical production is Texas' top-ranking industry as measured by value added by manufacture (the difference between the cost of raw materials and the value of products). In 1973, more than 61,000 workers were employed in chemical

plants; the output value in 1970 totalled \$4.8 billion. The most important product group is industrial organic chemicals, the basic materials from which synthetic fibers and plastics, rubber, lubricants and hundreds of other products are made.

In addition to the onshore economic effects due to the refining of crude oil, additional economic activity would result from the further processing of fractions of the crude oil, natural gas and petroleum liquids in petrochemical plants. The following description of the petrochemical industry of Texas was obtained from Whitehorn (1973).

The petrochemical industry in Texas is large, complex and integrated. It exerts a strong influence on industrial activities and provides a tremendous economic impact upon the state's economy. Petrochemicals were defined by Whitehorn for his report as those chemicals derived from petroleum and/or natural gas, but excluding all fuel and energy products such as gasoline, fuel oil, natural gas for fuel, kerosene, lubricating oils, as well as asphalt, wax and coke.

A 1972 survey, cited to Whitehorn, identified eighty-two firms operating 139 petrochemical manufacturing plants in Texas. While there were plants located in every part of the state, more than sixty-seven percent by number and eighty-eight percent by capacity were located in the coastal zone.

By volume, the Texas Gulf coast has the greatest United States concentration of chemical plants, producing more than forty percent

of every basic petrochemical, eighty percent of the synthetic rubber, and sixty percent of the nation's sulfur. By conservative estimates, the total production of petrochemicals in Texas in 1971 was between 75 and 85 billion pounds. Ethylene is produced in greatest quantity, with propylene and benzene next. Texas' petrochemical industry began during the 1920's. The 1950's and early 1960's marked the industry's greatest growth, ranging annually from ten to nearly twenty percent. Although it dipped in the late 1960's, the growth rate for the next few years appears to be good with estimates between seven and eight percent annually (Whitehorn, 1973).

Table 67 presents a ranking of factors given by industry leaders as deterrents to the growth of petrochemical firms or plants within Texas or in portions of the state.

These ten factors are selected as the principal deterrents to growth. Other factors mentioned by Whitehorn include inadequate fresh water supply, urban population growth, construction costs and depressed sulfur market.

Representatives from sixty-eight petrochemical firms also ranked those economic factors which could change the future level of activity in their operations. Table 68 presents the economic factors ranked in order of importance.

A similar ranking of technological factors that could change the future level of petrochemical activity in Texas included new and improved processes, new or improved product development, environmental control technology and the development of alternative fuel

Table 67. Deterrents to Growth in Texas

| Factors | Rank |
|---|---|
| Shortage of feedstocks | 1 |
| Remoteness from main market area | 2 |
| Energy (fuel) availability and cost | 3 |
| High state and local taxes and inequity in taxes | 4 |
| Transportation costs including high rail rates | 5 |
| Raw material costs | 6 |
| Saturation of some type of processing plants | 7 |
| Labor costs | 8 |
| Pollution abatement laws too stringent | 9 |
| Land transportation to markets | 10 |

Source: Whitehorn, 1973

Table 68. Economic Factors Which May Change the Future Level of Petrochemical Activity in Texas

| Factors | Rank |
|---|---|
| Availability and cost of feedstocks | 1 |
| Availability and cost of energy sources | 2 |
| Product demand and prices | 3 |
| Labor costs | 4 |
| Foreign imports and competition | 5 |
| Government regulations (safety, environment, price, etc.) | 6 |
| Transportation costs | 7 |
| Tax levels | 8 |
| Environmental costs | 9 |
| Product distribution costs | 10 |

Source: Whitehorn, 1973

(energy) sources.

Late in the year 1972, a survey revealed that 622 petrochemical plants were operating within the United States. Of this total number of plants, approximately twenty-two percent were located in Texas. More than two-thirds of the plants representing almost ninety percent of the producing capacity were located in the coastal zone of Texas. During the period 1950-59, twenty-one plants commenced operations; during the period 1960-69, seventeen plants went on stream.

The most important reason cited for the growth of the petrochemical industry in Texas is "nearness to raw materials". Other factors influencing the development of this industry have included the availability of an existing facility; the availability of transportation, labor and land; and nearness to markets.

c. Petroleum related industries in Louisiana

The following description of some of the important industries in the Louisiana coastal zone was published in the Louisiana Advisory Commission Coastal Marine Resources, 1973a. The following description of the more important industries in the coastal zone parishes by the Louisiana Department of Commerce and Industry was presented in a report to the Commission in February, 1972.

Industry in the coastal region is dominated by petroleum refining, petrochemical production, ship and boat building, food processing and primary metals. Apparel making, metal fabrication, and pulp and papermaking are also important industries. Petroleum refining

and petrochemicals are by far the largest. More than $5 billion has been invested in these industries in the coastal region since World War II and most of thes 32,000 plus workers employed in these industries work in the coastal parishes. There are approximately one hundred major petroleum and petrochemical plants in Louisiana making the state one of the principal producers in the United States. A number of the facilities are among the largest of their kind in the world. Over the last ten years Louisiana has attracted about ten percent of all new investment in chemical and petroleum refining expenditures in this country.

Ship and boat building continue to be a mainstay in the state's industrial economy. A shipyard is the single largest employer in Louisiana, with a work force ranging upward to ten thousand at times. The Avondale yards and other smaller yards specialize in supplying the needs of the offshore oil and gas industry with drilling platform, tugs, barges, crewboats and other specialized vessels that are constructed in Louisiana. Boats for commercial fishing and pleasure use are built in small yards scattered across the coastal region.

Specific areas within Louisiana with important concentrations of refineries and petrochemical plants include Baton Rouge, New Orleans and Lake Charles. The Lower Mississippi Region Comprehensive Study includes descriptions and projections for significant economic and industrial factors. Water Resource Planning Area 8 includes ten Louisiana parishes and Amite County, Mississippi, and includes the Baton Rouge area. An economic description of this area empha-

sizes the importance of the Baton Rouge industrial development.

Baton Rouge, the capital of Louisiana, is a major center of petroleum and chemical industries. It is situated on the Mississippi River two hundred miles from the Gulf of Mexico at the head of navigation for ocean-going vessels. The total value of industrial investment along the banks of the Mississippi River in WRPA 8 since 1946, has been $1.9 billion ($0.6 billion between 1946 and 1960, and $1.3 billion between 1961 and 1971). In 1967, East Baton Rouge Parish accounted for eighty-one percent of the area's $564.1 million value added by manufacturing. Petroleum refineries, the industrial base of the city, are supplied by nearby oil fields in south Louisiana. Many plants in the city either supply refinery needs, further process refinery products, or are engaged in related work.

Water Resource Planning Area 9 included a fourteen parish area extending from the border with Texas to the basin of the Atchafalaya River, bordering the Gulf of Mexico. WRPA[1/] 9 is rich in oil, natural gas, salt, sulfur, sand and gravel, and clays. The development of oil and natural gas resources has contributed more than any other factor to the progress of the area and to the rapid strides made in the raising of living standards and industrial growth. Oil and gas fields are located throughout the area as well as offshore in the Gulf of Mexico. Salt deposits are located on the eastern and western borders, and sulfur is mined in Calcasieu Parish.

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1/ Water Resource Planning Area

Sand and gravel are produced in nine parishes, and clays are mined in two. The total value of mineral production in WRPA 9 in 1969, was $1.57 billion, or thirty-three percent of the Louisiana total of $4.7 billion.

A combination of varied natural resources, water access, geographical location, and road and rail connections has made WRPA 9 an attractive location for industrial firms. The extent and quality of these resources are attested to by some of the Nation's major chemical producers having developed a multi-million-dollar petrochemical complex around Lake Charles. Natural resources have also been of great importance to Lafayette, Louisiana, as it has become the area headquarters and service center for the oil and gas industry. Industrial growth has also been enhanced by the existence of the deepwater port of Lake Charles.

Water Resource Planning Area 10 includes the New Orleans SMSA 1/ (Jefferson, Orleans, St. Bernard and St. Tammany parishes). Due to the presence of varied natural resources and its location on crossroads of internal and foreign commerce, WRPA 10 has experienced remarkable industrial development. A vast complex of petrochemical plants has been developed in recent years along the Mississippi River. Other industries have grown up around such native resources as sulfur, salt and sugar, and imported products such as bauxite, gypsum and coffee have also contributed to industrial development.

6. Transportation systems

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1/ Standard Metropolitan Statistical Area

During the year 1973, refineries located in Texas and Louisiana Gulf refining districts used inputs of crude petroleum, unfinished oils rerun, natural gas liquids and other hydrocarbons.

During 1974, refineries in Texas and Louisiana received crude oil from producing wells in the same state as the refinery location, from producing wells in other states and imported crude oil from foreign nations (Table 69).

Table 69. Transportation of Crude Oil in 1974

| Area | Pipelines | Tank Cars & Trucks | Tankers & Barges |
|---|---|---|---|
| Alabama | | | |
| Domestic crude | 4,285 1/ | 124 | 6,872 |
| Foreign crude | --- | --- | 272 |
| Louisiana | | | |
| Domestic crude | 415,079 | 5,084 | 96,370 |
| Foreign crude | --- | --- | 16,510 |
| Mississippi | | | |
| Domestic crude | 91,380 | 1,823 | --- |
| Foreign crude | --- | --- | --- |
| Texas | | | |
| Domestic crude | 920,773 | 9,619 | 115,054 |
| Foreign crude | --- | --- | 128,872 |
| Totals | 1,413,517 | 16,650 | 363,950 |

1/ All figures shown are in thousands of barrels

Source: United States Department of the Interior, 1974h

These figures show the relative importance of pipeline transportation in providing means for the delivery of crude petroleum to refineries in the four state area.

Data included in Stephens (1973) presents information that gathering lines, ranging in diameter from two inches to twelve inches in the four state area amounted to more than 27,000 miles as of January, 1971. Most of this mileage was located in Texas. An additional 32,887 miles of crude oil trunkline also were present in these states on January 1, 1974 (Figure 28).

Refined products are shipped by pipeline and water transport. On January 1, 1971, product pipelines, ranging in diameter from less than four inches to more than twenty-four inches, joined refining and consuming centers. More than 17,000 miles of product pipelines were located in the states of Alabama, Florida, Louisiana, Mississippi and Texas (Figure 29).

Table 70 presents the quantities of crude oil and products that were moved by tanker and barge from the Gulf coast to other areas of the United States during the period January to May of the years 1973 and 1974.

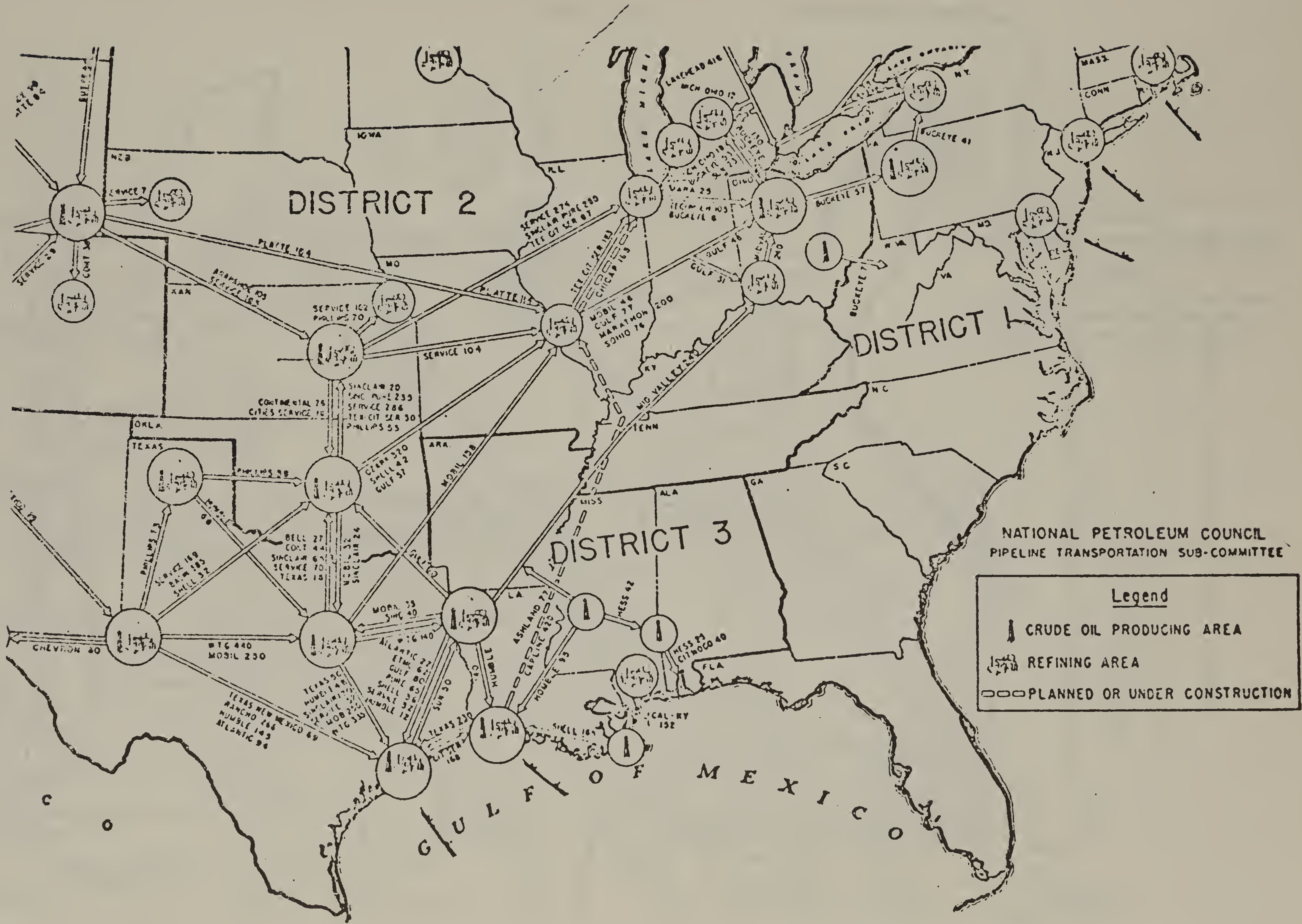



Figure 28 Crude Oil Pipeline Capacities

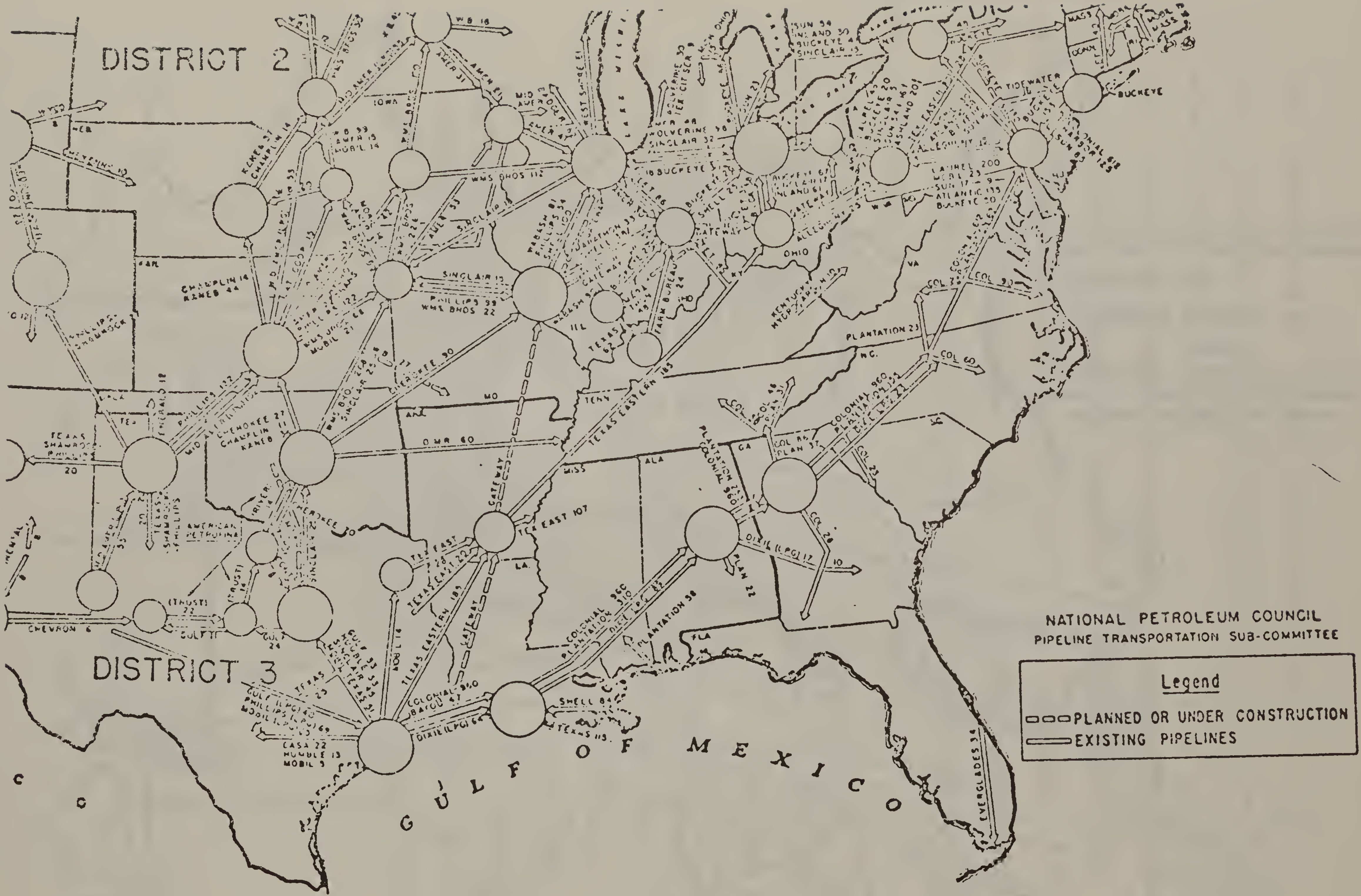



Figure 29 Product Pipeline Capacities

Table 70. Water Transport of Crude Oil and Products

| | January to May 1974 | 1973 |
|---|---|---|
| **Gulf Coast to East Coast** | | |
| Crude oil | 30,513[1/] | 29,620 |
| Unfinished oils | 9,301 | 6,998 |
| Products | 155,515 | 183,078 |
| Totals | 195,329 | 219,696 |
| **Gulf Coast to P.A.D. District II** | | |
| Crude oil | 4,871 | 4,365 |
| Unfinished oils | 8 | 18 |
| Products | 26,557 | 27,538 |
| Totals | 31,436 | 31,921 |
| **Gulf Coast to West Coast** | | |
| Crude oil | 564 | --- |
| Unfinished oils | --- | 113 |
| Products | 5,371 | 638 |
| Totals | 5,935 | 751 |

1/ All figures are in thousands of barrels

Source: United States Department of the Interior, 1974h.

J. Future Environment without the Proposal

The addition of the oil and gas produced as a result of this sale to the quantities of oil and gas currently being produced on the outer continental shelf in the Gulf of Mexico can be expected to continue the use of facilities installed for the transportation and processing of oil and gas reserves developed from previous state and federal offshore lease sales.

Production developed in onshore areas prior to, concurrent with and subsequent to production developed in the offshore areas also requires production, transportation and processing facilities. In the event that this sale was not held, it is considered probable that the skilled and unskilled labor, specialized equipment and other facilities that would be employed in the development of leases awarded as a result of Sale 41 would be employed in the specialized activity of exploring for, producing, processing and transporting oil and gas in an alternate area.

The resultant economic and environmental impact of these activities in other areas can not be known at this time, as it would be necessary to delineate these areas in a precise fashion in order to estimate these impacts. It is possible that the resources would be employed in the onshore areas adjacent to the offshore areas; in which case, the economic impact would be similar to the impact anticipated to result from this sale.

Given the extensive development of industries supporting the offshore production of oil and gas, and the extensive development of

industries related to the processing of oil and gas, additional supplies of oil and gas from any source in the Gulf of Mexico area are likely to be processed within existing facilities in the area.

It is probable that industry interest in the OCS indicates that larger quantities of oil and gas may be obtained for a given investment dollar. If this speculation is valid, it suggests that outer continental shelf production is efficient in the economic sense, in that a larger return can be anticipated from a smaller expenditure of scarce resources.

A further observation governing the continued operation of the refining industry, and industries utilizing the products of refineries may be in order. It is probable that existing refineries within the Gulf of Mexico coastal area will continue to operate as long as demand for the products continue. In the event that sufficient feed stock is not available, imported crude oils will be utilized. According to the February, 1975 issue of the Monthly Energy Review, published by the Federal Energy Administration, imports of crude oil amounted to approximately 3.9 million barrels per day, compared to domestic production of an estimated 8.5 million barrels per day during December, 1974.

The environmental effects of additional onshore production, and/or additional crude oil imports to the existing refining centers, must be considered in determining the status of the future environment of the Gulf of Mexico region in the event that this proposed lease sale is not implemented.

# III. ENVIRONMENTAL IMPACT OF THE PROPOSED SALE

## A. Impact on the Living Components of the Environment; The Gulf of Mexico and Coastal Zone Regions

### 1. Impact on Plankton

Numerous phytoplankton and zooplankton species occur throughout the Gulf of Mexico in the area of this proposed sale. The northern area of the Gulf of Mexico is no different from any other tropical or subtropical body of water in regards to plankton composition and biomass (general Gulf, Graphic 3, Volume 3).

The U. S. Geological Survey (USGS) estimated that there will be 695 tons of drill cuttings discharged per each 10,000 foot well. They further estimate that from 150-400 wells may be required from this proposed sale each requiring approximately 10-14 days drilling time for each well; however, wells drilled in hard bottoms may require between 45 to 90 days. In accordance with Federal Regulations, OCS Order No. 7 the cuttings will be washed of oil. This mud contains a variety of materials, including the wastes from various industrial processes. The basic ingredients of typical drilling mud consist of inert natural materials, i.e., bentonite clay, powdered limestone, and barium sulfate. Some additives may contain materials which are not inert. Appendix D (Table 1) lists ingredients of a characteristic sea water based drilling mud used to drill a typical well in the Gulf.

Since this mud will enter the marine environment through adherence to cuttings, accidents while drilling, or overboard spillage from

drilling rig, we feel that a localized and temporary impact could occur at the discharge point. Recovery rates would be rapid due to redistribution of similar species from adjacent areas by currents.

The discharge of drill cuttings and mud will produce temporary turbidity effects in the euphotic (lighted) zone; therefore, reducing the amount of underwater illumination in the immediate vicinity of the drilling rig. The effects of this activity will be short-lived and highly localized, immediately adjacent to the drilling area, resulting in a decrease in primary production-photosynthesis by local population of autotrophic photoplankton. In addition, planktonic filter feeding organisms will suffer physiological stress and death. However, both of these effects will not result in any measurable interference with the general level of productivity for each area adjacent to the drill rig. We assume that redistribution of similar species from adjacent areas by currents will offset these minimal effects associated with drill cuttings and recovery would be rapid due to the localized nature of the impact. However, no specific study of this problem has been made.

USGS estimates that 50-100 miles of new pipelines will result from this sale. Of the 135 tracts offered, approximately 40 percent occur in water depths greater than 200 feet where no burial will be required unless the pipeline crosses the 200 foot contour shoreward. If pipelines are needed in the remaining tracts, they will be buried. In areas where pipeline burial would be necessary, it would be accomplished by hydraulic jetting. This would increase the turbidity and the BOD loading in waters in the immediate construction area. Possible

resuspension of toxic materials, i.e., pesticides/heavy metals also occur in coastal waters.

There may be a temporary decrease in primary phytoplanktonic production from pipeline burial in offshore waters. This impact would affect local planktonic populations, but should not adversely affect the functioning of the total marine ecosystem, because of the short time period involved, the jetting barge is continuously moving when burial is being completed; and, because of the small area of impact, approximately a fifty-foot wide area. We also estimate that there would be the same effect on estuarine species from pipeline construction through the coastal zone. However, no definitive study has been conducted.

Assuming that the formation water would be discharged from the platforms into the Gulf, the following range of values for the following parameters could be expected:

| Parameters | Range |
|---|---|
| Oil (mg/l) | 6-827 (EPA, 1974) |
| Temperature ($^{o}$F) | 50-140 (USGS, 1975) |
| pH | 4.5 - 8.5 (USGS, 1975) |
| Suspended solids (mg/l) | 12-656 (EPA, 1974) |
| Settled solids (mg/l) | 0-125 (USGS, 1975) |

Volume of daily discharges for formation water from each platform varies; however, U. S. Geological Survey reported that 298,217 barrels were discharged per day as of October, 1973.

The resultant thermal, osmotic and chemical (contaminants and oxygen) stresses on indigenour plankton and neuston for offshore waters, probably would be confined over a relatively limited area at the

discharge point of the euphotic zone in the Gulf in the vicinity of each platform for the duration of production phase. Effects include physiological stress from low dissolved oxygen and high concentrations of dissolved salts. These effects would occur a relatively short distance from the point of discharge, mixing processes would be expected to disperse contaminants, modify temperatures and salinities of the formation water to levels indistinguishable from seawater. Oxygenation of these waters to supersaturated levels would proceed rapidly. An unknown effect could be uptake of water solubles aromatics not removed in the separation process.

No effect from biological waste disposal is expected on plankton. OCS Order No. 8 requires that treated sewage effluent contain no more than 50 ppm BOD, no more than 150 ppm suspended solids and a minimum chlorine residual of 1.0 mg/l. Since the volume of this effluent released per day will be very small, no detectable effect on plankton is anticipated.

A breakdown of tracts offered, show that thirty-seven percent of the acreage is gas prone, three percent is oil prone and sixty percent is oil and gas prone. The probability of a major (> 100,000 gal.) oil spill resulting from this proposed sale is unknown.

Other sources for oil spills are chronic low level leakage from production platforms and pipeline leakages. The following is a synopsis of pertinent studies that have been conducted concerning the effects of oil on plankton. These studies include both field and laboratory investigations. Thus, it is possible to draw from

these studies some general conclusions as to how phytoplankton and zooplankton will be affected if oil is present in the marine environment.

Ray and Mills (1974) and Mills (1974) showed that phytoplankton exposed to water-soluble fractions of south Louisiana crude oil, Kuwait crude oil, No. 2 fuel oil, and Bunker C oil had reduced primary productivity. However, they noted that once the exposure to oil was terminated, the phytoplankton resumed a normal growth rate within a few days. They conclude that once a spill episode has passed, only a few cells need survive to repopulate a given area rapidly. Recruitment from nearby unaffected areas would also achieve a normal phytoplankton population quickly.

The Gulf Universities Research Consortium (GURC) study (1974) reported the following on the ecological impact of oil drilling and production on phytoplankton standing crop, primary productivity, nutrients, etc.:

> Chlorophyll a values were consistently higher at all depths sampled (except at the surface) at the production platform as compared to the control site. At both sampling sites, a marked increase in chlorophyll a in the samples collected near the bottom was noted and was indicative of large cell populations of the water column.
>
> Primary productivity: Data at both the platform and control sites showed remarkably similar results. Average daily primary production at the platform is 1.06 g $C/m^2$ compared to 1.03 g $C/m^2$ at the control site.
>
> Phaeo-pigments (degradation production of chlorophyll a): The distribution of the phaeo-pigments in the OEI area showed a trend similar to that of chlorophyll a. Very high values of phaeo-pigment were found at the bottom of the control site indicating large cell populations at some prior time.

Photosynthetic Index (P.I.): (or assimilation number) is usually considered as a "measure of the vitality of the phytoplankton organsism". During this study, the P.I. at the control site was found to be higher than at the platform (38.95 and 28.57 mg C/mg Chl. a, respectively). The values of the P.I. at both sampling sites reflected healthy growth of phytoplankton.

Cell counts: The total cell counts/liter were found to be much higher at the platform than at the control site.

Number of species of phytoplankton: The number of species of diatoms and dinoflagellates were found not to vary appreciably between the platform and control sites.

Seasonal variations: In primary production, standing crop of phytoplankton, nutrient salt concentrations, cell counts, and number of species of diatoms and dinoflagellates were observed at both the platform and the control site. As expected from seasonal impact, biological productivity is at its lowest ebb during the November-January period. Maximum phytoplankton density (climaxing in a bloom state) was reached during April, 1973 (flood stage).

Comparison of Offshore Ecology Investigation (OEI) data with that of the Gulf of Mexico: When we compare the primary productivity, standing crop and nutrient data collected in the OEI region, with data collected in the Gulf of Mexico during the past nine years, we found that OEI data to be much higher than those collected from both the open Gulf of Mexico and on the continental shelf off Panama City, Florida.

In addition, the GURC study (1974) investigated two zooplankton communities in the bay and offshore areas of Louisiana during the Offshore Ecology Investigation. One was the Timbalier Bay assemblage consisting of coastal-neritic and estuarine species, the other, a community 15-25 km. offshore consisting of oceanic, slope-oceanic, shelf and coastal neritic faunas. Neither diversity values nor biomass was significantly different between control sites and production/drilling sites whether in the bay or offshore. On comparison of the OEI data with that generated in 1952, it was found that there have been no

detectable changes in the calanoid copepod fauna of the total population in the past 20 years. The natural and seasonal variability of the OEI region was again demonstrated in the control and platform site variability; was markedly less than the range of seasonal variability.

Important work by Mironov (1970) indicated that planktonic larvae of benthic and nektic animals (meroplankton) are more sensitive than permanent members of the plankton (holoplankton). Therefore, a threat to populations of various finfish and shell fish exists for oil prone areas.

In addition, coating by oil of various plankton species (i.e., large coelenterates) could have an adverse affect on planktonic populations, Moore et al. (1974) reported that planktonic species are not confined to surface waters and, therefore, are not necessarily exposed to an oil spill. However, their largely passive drifting with the currents implies the possibility of being exposed to surface conditions. Neuston, strictly surface dwelling plankton, are clearly threatened. However, active vertical migrators, in a worse case assumption, are also potentially threatened.

The above literature indicates that the plankton populations of the Gulf of Mexico ecosystem will probably be able to absorb the impact of a major oil spill and recover fairly rapidly. The greatest number of planktonic organisms directly killed from a spill greater than 50 barrels would be found in the neuston or the community in the upper five cm. of the Gulf surface. Since annual biological

productivity is greatest in spring and winter, especially along the coast in upwelling areas, a spill in this part of the year would do the most damage to plankton productivity and standing crop.

Impacts to planktonic organisms from chronic low-level discharges include direct lethality, reduction in photosynthetic effeciency, interference with chemical communication and general physiological stress to those organisms which are carried into a contaminated zone for that period of time that they are exposed to hydrocarbon concentrations above the effective level. The literature surveyed and the studies conducted so far indicate that the magnitude of this impact as it affects the total marine ecosystem is still in the unknown category.

Based on geographic locations of oil prone tracts for this proposed sale, those areas that an impact from spilled oil could effect various populations of plankton include: all tracts off Florida, east of the Mississippi River, mouth of Mississippi River and western Louisiana.

2. Impact on Benthos

Benthic assemblages and communities of this proposed sale can be broadly described as bay and sound, beach, shallow shelf, intermediate shelf, deep shelf and slope. Within these broad areas, more specific assemblages or communities can be described for shrimp grounds, oyster reefs, sand bottoms, silt and clay bottoms, and hard banks. This discussion will include all except beaches and hard banks which will be discussed under biologically sensitive areas.

The number of exploratory wells contemplated in this proposed lease sale are between 150-400. The approximate volume of cuttings from each exploratory well of 10,000 feet would be 1700 barrels and would require approximately 10 to 14 days of drilling; however, wells drilled in hard bottoms may require between 45 to 90 days.

Deposition of 695 tons of cuttings during drilling of each exploratory well will disrupt local benthic environments. All non-mobile benthic forms in the affected area will be smothered. We estimate that in the absence of toxic substances, recolonization of the substrate should begin after one breeding season. The presence of hydrocarbons or drilling muds will retard this return depending on the duration of hydrocarbons present. Recolonization should occur after a season's duraction because of the absence of most hydrocarbons from drill cuttings. If the bottom is different in texture and composition, it may be colonized by components of the local population resulting in an altered species distribution. This could, in

turn, alter community structure in that part of the food chain is dependent upon benthic species.

GURC (1974) reported that populations of localized benthic epifauna (i.e., sponges, coelenterates, bryozoans and others adjacent to the platforms) may be buried and smothered by drill cuttings: however, this effect is only temporary.

We expect that coarser materials would comprise the bulk of the cuttings and cuttings mound, if any; finer components would be distributed in response to prevailing currents and would grade into natural sediments of the immediate area. Benthic organisms and natural erosional-depositional forces would rework the sediments so that downstream cuttings deposition would be indistinguishable from surrounding sediments. We believe that the duration of the impact at each drilling location during and after drilling would be dependent upon: type of disposal; type of cuttings and size of area impacted; seasonal reproduction cycles and recolonization of indigenous species; time for colonization by different species from adjacent area; natural bottom sediment type; and volume of cuttings.

In conformance with federal regulations, OCS Order No. 7, the cuttings will be washed of oil. However, possible adverse effects to benthos might result from loss of toxic drilling muds due to adherence to cuttings, accidents while drilling or overboard spillage from drilling rig.

Drilling companies have utilized a wide variety of materials,

including the wastes from various industrial processes. For example, ferrochrome lignosulfonate is a by-product of the paper industry. The basic ingredients of typical drilling mud consist of inert natural materials, such as bentonite clay, powdered limestone and barium sulfate.

Some additives may contain materials which are not inert. Appendix D (Table 1) lists ingredients of a characteristic sea water based drilling mud used to drill a typical well in the Gulf of Mexico. As previously mentioned, a small percentage of this mud will enter Gulf waters.

In any event, we feel that the benthic community in the immediate vicinity of the discharge could be impacted if sufficient quantities reached bottom. However, this possibility is remote because of large dilution factor upon entering Gulf waters.

In addition, sodium chromate is used in the amount of 0.1 to 4.0 pounds per barrel of water base drilling mud as an extender to replenish chromium to the chromium lignosulfonate in water base drilling and systems. At relatively high temperature, its usage is occasional to common, varying with different drilling operatings and drill mud companies. Because of its low concentration in drilling mud and the large dilution factor upon disposal, we expect the toxicity to benthic populations to be very localized and temporary at the discharge point if sufficient quantities reached bottom.

Oil based muds are seldom used and are not considered in this discussion.

We feel that the area to be impacted from the discharge of drill mud and cuttings is dependent upon a number of factors: drill mud compositions and weight; water currents; sea conditions; type of disposal;velocity of materials through disposal of pipe, if any; water depth of disposal pipe and size of pipe, if any; type of substrate being drilled or size of particles suspended; size of drill hole and volume of cuttings; geographic location of drilling platforms in Gulf of Mexico; and dispersion rate of drilling muds and cuttings in water column.

Recovery rates would vary depending on type and size of population impacted. In general, the initial stages of recovery are characterized by opportunistic species that are often very productive, with a much longer time required to restore the community to one that supports more long lived species.

In water depths of less than 200 feet, new common carrier pipelines are entrenched by jetting away the sediment beneath the pipe and allowing the pipe to settle into the underlying trench at lease three feet. Partial burial takes place quite rapidly as the disturbed sediments slide and settle back into the trench.

The jetting process physically disrupts the sediments in its path, also causes resuspension of large quantities of sediment. This process would have the effect of displacing benthic organisms and would result in direct mortality to softer life forms and indirect mortality to others through increased vulnerability to predators. Although recolonization would begin immediately, the native fauna could not be fully restored until seasonal reproduction cycles had been completed by representative species from adjacent areas; these would provide a supply of larvae to settle and enter the reworked substrate.

Turbidity resulting from resuspended sediment is capable of producing an adverse impact on filter-feeding molluscan and crustacean benthos populations by clogging the filter-feeding apparatus or blocking respiratory surfaces. This impact is temporary, occurring during burial operations, lasting from several hours to a few days, and would effect those populations adjacent to the pipeline. Casual observation has revealed that ocean currents carry the sediment and redeposit it at various distances, depending upon the particle size of the sediment. Moreover, these same factors along with the rate of the burial operation determine the length of time in suspension.

Another possible source of impact during pipeline dredging is the resuspension of toxic heavy metals and hydrocarbon pesticides that may have been deposited in the area by polluted stream, river or bay and land runoff, but the predictions for the occurrence, location, scope and duration of the impacts are unknown. The possibility exists that these toxic materials could be ingested by lower marine life and could then be magnified through the food chain until they accumulated in serious quantities in top carnivores, including species harvested for human food. However, the further offshore the less likelihood this impact would occur due to distance from polluted streams and/or land runoff.

Beyond 200 feet, however, exposed pipelines will be beneficial and provide a hard substrate that will be quickly colonized in much the same way as platforms are. This will result in wider variety of organisms, and greater biomass available for input into the food chain

from settlement and growth of sessile epibenthos (fouling organisms). They will also act as shelters for more susceptible organisms or larval forms of benthos.

As previously mentioned, the miles of pipeline expected from this sale are 50-100. Locations of these pipelines are unknown. We expect that the area impacted is localized within fifty feet of the particular operation throughout the water column. However, this area may decrease or increase because of the following variables: water currents, sea conditions, water depth, natural bottom sediment and dispersion rate of bottom sediments from jetting operation.

Recovery rates would be dependent upon seasonal reproduction cycles and recolonization by indigenous and other species. Estimates for recolonization range from months to several years.

No effect from biological waste disposal is expected on benthos. OCS Order No. 8 required that treated sewage effluent contain no more than 50 ppm BOD, no more than 150 ppm suspended solids and not greater than 1.0 mg/l of chlorine residuals. Since the volume of this effluent released per day will be very small, no detectable effect on benthos is anticipated.

Assuming that the formation water would be discharged from the platforms into the Gulf, the following range of values for the following parameters could be expected;

| Parameters | Range |
|---|---|
| Oil (mg/l) | 6-827 (EPA, 1974) |
| Temperature (°F) | 50-140 (USGS, 1975) |
| pH | 4.5 - 8.5 (USGS, 1975) |
| Suspended solids (mg/l) | 12-656 (EPA, 1974) |
| Settled solids (mg/l) | 0-125 (USGS, 1975) |

We feel that these effluents will affect only surface and near-surface organisms and will have no impact on benthos at the point of discharge because of high dilution factor upon entering the Gulf.

Of the tracts nominated, thirty-seven percent are gas prone, three percent are oil and sixty percent are oil and gas prone. The probability of a major oil spill resulting from this proposed sale is unknown. Other sources for oil spills are chronic low level leakage from production platform and pipeline leakages.

The following is a synopis of pertinent studies that have been conducted concerning the effect of oil on benthos. These studies include both field and laboratory investigations. Thus, it is possible to draw from these studies some general conclusions to how benthos will be affected if oil is present in the marine environment.

For discussion purposes, benthic fauna can be divided into; gastropods (snail, limpets, etc.), bivalves (oysters, clams, etc.), crustaceans (shrimp, crabs, lobsters, etc.) and all other (worms, anemones, etc.). Apparently, gastropods are the most resistant to the toxic effect of petroleum and crustaceans are the most sensitive (Moore, et al., 1974).

Most gastropod studies indicate a rather high resistance to hydrocarbon toxicity and periwinkles (Littorina littorea), a common intertidal snail, are apparently very resistant. The critical concentration may be 100-200 ppm or more. Limpets (Patella vulgata) demonstrate the only significant deviation and appear to have a critical threshold concentration of less than 5 ppm. The relatively high resistance of most gastropods may be due to secretion of a mucous substance (Shelton, 1972).

Bivalves, including oysters, clams, cockles and mussels, are moderately resistant to oil. The ability to close their shells and seal off the ambient water mass acts as an effective protection mechanism. However, this closed condition cannot be maintained indefinitely, and, in fact, cockles tend to "gape" making them more susceptible (Simpson, 1968). Typical critical concentrations for most bivalves are 5-50 ppm of petroleum hydrocarbons.

Both benthic crustaceans and other miscellaneous benthic organisms are apparently fairly sensitive to petroleum hydrocarbons. Threshold concentrations appear to be 1-10 ppm of petroleum hydrocarbons. Burrowing organisms may also be threatened by alternations in the substrate texture and structure.

Data from the benthic faunal studies by GURC (1974) gave the following results on the impact of daily offshore petroleum operations on benthic fauna and flora for offshore and bay areas:

(1) Within Timbalier Bay, in excess of 165 bottom-dwelling invertebrate animals were routinely collected for study. Investigations of species diversity and biomass show the expected seasonal variations and give evidence of typical healthy unpolluted bottoms not experiencing abnormal stress

related to drilling or production activities. Trawl hauls at and near the sampling stations did not show significantly different Catches-Per-Unit-Effort (CPUE) although there were variations in the weight-haul values which are thought to reflect the availability of organic detrital foodstuffs.

Offshore, faunal affinities and species diversities of platform and control sites showed that both sets of stations belonged to a common biocoenosis. The variability in biomass was correlatable with sediment type with season, or with the low dissolved oxygen associated with the 1973 flood.

(2) Distribution, density, and diversity of benthic plants of Timbalier Bay are a product of the natural environment there and have not been significantly affected by production or drilling activities. Three features of the benthic flora substantiate this view. There are (a) the number of species of benthic algae in Timbalier Bay; sixty. Compare with the 67 species of Mississippi Sound and 51 species from the region of the Chandeleur Islands. These latter two environments were thought more favorable environments for marine algae and seagrasses; however, hundres of tons of the red algae, Gracilariopsis sjoestedtii, developed in Timbalier Bay in 1972, and (b) could not have if the bay had not been in good ecological health, and (c) beds of seagrass were not expected, yet extensive colonies of Diplanthera wrightii were recorded - perhaps for the first time for this portion of Louisiana.

(3) Offshore, neither benthic algae nor seagrasses are found on the bottom because of the persistent turbid layer which excludes light. The platforms, however, function as artificial reefs and provide an anchorage for more than 60 species of benthic algae. These algae contribute greatly to the region's primary productivity and they are heavily grazed by herbivores.

On incorporation of hydrocarbons by benthic fauna, Blumer (1969) and Blumer, et al., (1970a) have indicated that bivalves exposed to oil may retain aromatic hydrocarbons for a period of months or perhaps indefinitely. However, Lee, et al., (1972a) demonstrated that the mussel Mytilus edulis accumulated several different petroleum hydrocarbons

but released approximately 95% of these in a period of two weeks. Lee and Benson (1973) stated that petroleum hydrocarbons resulting from a distant small spill were accumulated by *Mytilus* but members of the same population showed no contamination three weeks after the spill. Teal and Stegeman (1973) exposed oysters to 106 ug/liter of a No. 2 fuel oil for periods of up to fifty days. They found that short term accumulation was correlated with the fat content of the oysters. The maximum levels of hydrocarbons detected in oyster tissues were 334 and 161 ug/g wet weight for high and low fat oysters, respectively. After one month in their post-exposure "cleaner" sea water system, the oysters still retained approximately 34 ug/g total petroleum hydrocarbons, but since there was a small amount of contamination in this system (11 ug/liter), continued low level accumulation could not be ruled out.

Corner, et al., (1973) observed that naphthalene is quickly detoxified and excreted by the spider crab, *Maia squinade*.

In addition, Anderson (1973) reported that oysters quickly purged themselves of oil when placed in oil-free seawater. This investigator used four different oils (South Louisiana crude oil, Kuwait crude oil, No. 2 fuel oil and Bunker C oil) and two different oysters (Pacific oyster and the American oyster, *Crassostrea virginica*). Anderson, et al., (1973) also reported the same results for brown shrimp (*Penaeus aztecus*) and the sheepshead minnow (*Cyrprinodon variegatus*) using identical methods. Vaughan (1973) also reported that oysters quickly purge themselves of oil when exposure ends and placed

in non-contaminated seawater.

Coating effects are principally associated with the higher boiling point fractions of oil (for example, oil which has been weathered so that the more toxic fractions have evaporated). The effects are usually in the intertidal zone involving both organisms and substrates. The necessary thickness of coating to cause mortality is not readily definable. Most species exposed to a coating of weathered crude oil are likely to be affected in some manner (Moore, et al., 1974).

The effects of habitat alteration or removal of species from an area involves intertidal and subtidal benthic species. Epifauna (species lying on the substrate) may be little affected by the physical presence of oil; however, infauna (species living in the substrate) can be expected to be more vulnerable to habitat alteration. Unfortunately, there is virtually no data on the relationship between the amount of oil present and the degree of suitability of the substrate for various species (Moore, et al.,1974)

Based on geographic locations of oil prone tracts for this proposed sale and using classifications of benthic communities of Parker (1960) for offshore Texas and Louisiana and Lyons and Collard (1974) for offshore Mississippi, Alabama and Western Florida; the following are potential areas with benthic assemblages that could be impacted from spilled oil. Adjacent areas could also be impacted if the spill was not contained or cleanup procedures were inadequate. In addition,

bottom sediments (western, central and eastern Gulf, Graphic 3, Vol. 3) are listed to help characterize the assemblage.

These assemblages include:

(1) High Island - three oil/gas prone tracts , Inner Shelf, silty clay

(2) East Cameron - four oil/gas prone tracts, Inner and Intermediate Shelf, sandy clay and sand.

(3) Vermilion - two oil/gas prone tracts, Inner Shelf, clay.

(4) Vermilion - South Addition - one oil/gas prone tract, Intermediate Shelf, sandy clay and silt.

(5) South Marsh - North Addition - two oil/gas prone tracts, Inner Shelf, clay.

(6) Eugene Island - one oil/gas prone tract - Intermediate Shelf, clay.

(7) Eugene Island - South Addition, one oil and two oil/gas prone tracts, Outer Shelf, silty clay.

(8) South Timbalier, one oil/gas prone tract, Inner Shelf, clay and silty clay.

(9) South Pass, one oil prone tract, Inner Shelf, silty clay.

(10) South Pass - South Addition, two oil/gas prone tracts, Outer Shelf, silty clay.

(11) Main Pass, one oil prone tract, Inner Shelf, silty sand and silty clay.

(12) Breton Sound, one oil prone tract, Inner Shelf, silty sand and silty clay.

(13) Mobile South No. 1, one oil/gas prone tract, Shallow and Middle Shelf I, sand.

(14) Mobile South No. 2, two oil/gas prone tracts, Deep Shelf, silty sand.

(15) Pensacola South No. 1, 5 oil/gas prone tracts, Middle Shelf I and II, sand.

(16) Apalachicola, two oil/gas prone tracts, Shallow and Middle Shelf I, sand.

(17) Apalachicola South, two oil/gas prone tracts, Middle Shelf I, sand.

(18) Tarpon Springs, 10 oil/gas prone tracts, Shallow and Middle Shelf I, sand.

(19) Tampa, 22 oil/gas prone tracts, Shallow, Middle Shelf I and Middle Shelf II, sand.

(20) Tampa West No. 1, 19 oil/gas prone tracts, Middle Shelf II, sand.

We assume from reviewing documented spills, that in the event of a large oil spill certain benthic assemblages will be affected because of water depth and associated turbidity of these waters. These include primarily the inner (shallow), intermediate (middle shelf I) shelf assemblages and intertidal or shoreward areas if oil reaches the shore. These assemblages seaward are less likely to be affected due to dispersion and dilution of crude oil through the water column. Also, quick response clean-up procedures, i.e., skimmers and containment of an oil spill will reduce the area impacted thus reducing the probability of oil reaching intertidal benthos. In the history of OCS leasing in the Gulf of Mexico no oil spill resulting from an OCS lease area has ever penetrated semi-enclosed embayments, estuaries or wetlands. Beaches will be discussed under biologically sensitive areas.

The recovery of contaminated areas varies greatly for benthic populations. Variables include flushing of the contaminated area, type of bottom sediments, the degree of isolation of its ecosystems and the kinds of organism that form them. In general, the early

stages of recovery are characterized by opportunistic species that are often very productive, with a much longer time required to restore the community to one that supports more long-lived species.

In summary, impacts resulting from: (1) Drilling will cause smothering and burial (especially near bottoms firm enough to support an epifaunal community) in the immediate area of drilling operation. Recovery will usually begin within months but biological recovery will not be complete for the epifaunal communities for at least severals years. (2) Pipeline burial will result in community disruption and destruction in the path of the 50 to 100 miles of pipeline corridor construction. Destruction will be minor except in depths of less than 200 feet. Even here destruction will probably be limited to a strip of about 100 feet wide along the pipeline path. Recovery will be in a matter of day for the mobil benthic organisms and one to several years for sessile organisms. (3) Resuspension of polluted sediments will result if pipeline laying or drilling operation occur by the outfalls of polluted bays, rivers or streams. Direct kill to benthic organisms will be of limited but unqualificable extent and duration. Pesticides could be accumlated in the food chain as the result of drilling or pipeline burial in these areas. This could be detrimental to certain individuals at the top of the food chain, although no widespread population fluctuation will result from these operations. (4) A large oil spill with a maximal amount of sinking oil would be the most detrimental to subtidal benthos. Since the literature indicates oil spills cause a range from extensive

destruction to slight or undetermidable amounts, we must conclude that some destruction will occur which could be covered as a result of a massive oil spill.

3. Impact on Nekton

Nekton are those organisms which remain suspended in the water and whose power of location are great enough to resist the set and drift of currents, being subject only to large scale physical forces. Five taxonomic categories: marine mammals and reptiles, fishes, cephalopod molluses and certain crustaceans, shrimp and swimming crabs, represent the active swimmers or nekton for the Gulf of Mexico.

Due to this ability of locomotion, we feel that nektonic organisms will avoid areas of contamination from oil thus little or no impact is anticipated. This hypothesis follows that of Nelson-Smith (1973). Moore, et al. (1973) reported an alternative hypothesis by Dr. M. A. Roberts, VIMS. Dr. Roberts stated that although nekton may be most dense in the impact zone compared to other depth zones, the densities are so small as to prevent recognition of a direct kill. In such a case, avoidance is not involved; however, the effect is the same; little or no impact.

In addition, Moore, et al.(1974) hypothesized three mechanisms by which oil may impact the individual fish (nekton) and thus the size and distribution of fish populations. They are:

(1) Egg and/or larval mortality on spawning and/or nursery grounds. Eggs and larvae may be affected by concentrations of soluble aromatic hydrocarbons in excess of 0.1 ppm (see Sec. IV.A.1).

(2) Adult mortality or failure to reach spawning grounds if the spill occurs in a confined, narrow or shallow waterway necessary for migration or spawning. Ana-

dromous (spawns in fresh water) fish crowding into an estuary would seem especially vulnerable to this hypothetical disaster.

(3) Loss of local breeding population or ability to breed due to contamination of spawning grounds, or the destruction of the nursery area by oil.

Since points (2) and (3) are not explored in the literature, we can do little more than indicate when species are anadromous, spawn in shallow water, or have restricted nursery sites. The significance of a threat to any species cannot be resolved with the available data.

However, we feel that the probability of a massive oil spill resulting from operations on the OCS impacting spawning or nursery areas to be very low because of the low number of oil prone tracts for this sale; distances of tracts involved; and the fact that in the history of OCS leasing in the Gulf no oil spill resulting from an OCS lease area has ever penetrated semi-enclosed embayments, estuaries or wetlands.

The occurence of sublethal (i.e. masking or interfering with prey detection, reproductive patterns, social behavior) effects are uncertain, but have the possibility of being an important impact of oil production in the marine environment. Studies conducted to date indicate that the severity of these impacts is uncertain (National Academy of Sciences, 1973).

We recognize that certain petroleum hydrocarbons can be accumulated by some, if not all, marine organisms and if ingested by humans, might become concentrated in body lipids. The pathways, the amount of retention, degree of concentration and possible

overall effects are not well known or understood. Nevertheless, there is concern that oil ingested by certain marine organisms may contribute to the new destruction of food values of fisheries resources. In addition, it is recognized that there is considerable uncertainty and an unknown potential for introduction of carcinogens into the human food chain if organisms are subjected to chronic, low-level pollution events. The evidence gathered to date suggests only that:

(1) Certain biogenic hydrocarbons are passed from prey to predator in the marine food chain and selectively magnified at selected higher levels.

(2) Some petroleum hydrocarbons are taken up by marine organisms, both flora and fauna.

(3) Certain hydrocarbons appear to be stable in body lipids. Stability in lipids is the key to food chain magnification of some chlorinated hydrocarbons and certain heavy metals.

(4) Certain hydrocarbons contain carcinogenic compounds (e.g. 4-Benzopyrene, extracts of which have caused skin cancer in mice). The significance of these events is as yet unknown.

Drilling operations (i.e., discharge of drill cuttings and mud, and toxic material) will have a temporary impact effect on bottom-dwelling fishes or nekton (GURC, 1974).

GURC (1974) reported that drilling rigs have a disruptive effect on bottom fishes as compared to an area where there are none. In shallow water, Timbalier Bay especially, drilling operations had very pronounced effect on the presence (i.e. fish species temporarily moved out of the vicinity of the drilling operations) of the majority of the species in the area. This was also true but to a lessor extent offshore. This adverse effect is obviously localized and temporary as evidenced by the fact that the make-up of the area's fish populations has not changed since the oil drilling began.

We also feel that this temporary disruptive effect will exist for pipeline placement and burial. These organixms will be exposed to increased turbidities and BOD, and possible resuspension of toxic materials.

No impact from biological waste disposal is anticipated due to the small amount discharged.

A beneficial impact resulting from the placement of exposed pipelines and production platforms is that they serve as artificial reefs. They provide: food in the form of encrusting algae, bryozoa, crustaceans and sponges; shelter in the various nooks and crannies, where juvenile fishes can escape predators; and visual orientation. Orientation is not understood, but the physical presence of objects in open water is widely acknowledged to attract many species of fish.

Dr. John B. Thompson, investigating for the Gulf Universities Research Consortium (GURC, 1974) found no evidence either harmful or beneficial effects on the placement and maintenance of the offshore

oil platforms on the fish and shellfish fauna on the open shelf. His study included the most abundant bottomfish trawl fauna of north central Gulf of Mexico, between longitudes of 89° 30' N. and 92° 30' W., and 10-75 fathoms across the continental shelf off Louisiana. Dr. Thompson used data from the work of the Bureau of Commercial Fisheries (now National Marine Fisheries Service), with the M/V Oregon and chartered vessels from 1950-65. This period saw the rise of the offshore oil industry in the study area. Dr. Thompson also stated that no trends were apparent through the period in either quantity or distribution of species studies. He also found a general trend toward diminution of trawl catch from east to west across the study area, which he attributed to current patterns and bottom type differences.

In summary, we feel that no significant impact has resulted on nekton from the placement and maintenance of the offshore oil platforms.

### 4. Impact on Biologically Sensitive Areas

For the purposes of this section, biologically sensitive areas for this lease sale area include shorelines and underwater banks.

#### a. Shorelines

Shorelines in the Gulf range from sandy to muddy, except for small and widely scattered pilings and jetties. Impacts on the shoreline could result from contamination by spilled oil and from disruption of substrate during pipeline burial excavations.

The construction activity expected for this proposed sale may require new pipelines to transmit oil and/or gas to onshore facilities. Thirty-seven percent of the tracts are estimated to be solely gas prone with three percent estimated as oil and the remaining sixty percent as oil and gas.

During pipeline laying operations, pipelines are buried by jetting up to a point where the jetting barge would be in danger of shoaling if further progress were made. From this point on, the pipeline is usually buried by the use of a suction, clamshell or bucket dredge. As this operation crosses the beach, it will disrupt and rework the sand for a width of approximately thirty to forty feet.

Impacts due to pipeline construction and burial operations, through the sandy to muddy shorelines, will result in the destruction and loss of habitat of benthic intertidal organisms.

Recovery is thought to be fairly rapid and would depend on the timing of reproductive cycles of organisms in adjacent areas. On the permanently exposed portion of the beach, devegetation could result in wind erosion, and wildlife species will be temporarily displaced from that portion of their habitat.

Another possible source of impact during pipeline dredging to shorelines is resuspension of toxic heavy metals and persistent pesticides that may have been deposited in the area by a polluted stream and land runoff. The possibility exists that these toxic materials could be ingested by lower marine life, and then be concentrated through the food chain, to higher forms including man.

Rutzler and Sterrer (1970) have pointed out that sandy shoreline (beaches) have a horizontal rather than vertical extension, and a large "internal" surface. Therefore, they act as high natural filters for the water transported in by waves and tides. In the case of an oil spill, large quantities of oil will be pressed into the sand, mixed with the subsurface return flow and transported to other areas. Rutzler and Sterrer (1970) found a large apparent decrease in the total number of individuals present in oiled sands, although they were unable to prove that this was a result of spilled oil due to a lack of baseline data.

During the Arrow spill study (Operation Oil, 1970), excavation of clams revealed oil extending down most burrows and often forming a pool at the bottom. Clams generally moved up the burrow to evade the pools, and sometimes left the entire substrate.

Some mortality occurred and even the live clams were moribund, although they recovered with prolonged exposure to air.

Mackin (1973) stated that the effects of oil in the intertidal zones, beaches, marshes and rocky shores are sometimes severe. The area of the beach zones is subject to heavy concentrations of oil and may be damaged if certain levels are reached.

In the event an oil spill reaches a piling or jett, damage to the benthic community is expected. Damage would depend on the level of concentration of the crude oil.

In summary, if oil were to be deposited on the moderate or low energy shoreline of the Gulf of Mexico, there would probably be a substantial kill of infauna. Removal of oil by natural means would probably be very slow and would require redistribution of the sand by storm tides and high-energy storm surf. Recover rates would range from months to years depending on reproduction cycles, recolonization and extent of contamination.

Once a spill arrives ashore, it is generally too late for completely and instantly effective mitigative measures, and cleanup itself may have unfavorable impacts.

The area located around the Mississippi Delta is the most oil prone of the sale and may have a high probability of being impacted by oil spills.

b. Reefal features

For this sale, three tracts contain part of the West or East Flower Garden (coral reef), and twenty-five tracts contain all

or part of an offshore fishing bank.

We have proposed that these tracts be offered with protective environmental stipulations (Section IV, D, lb and lc) promulgated for the Flower Garden reefs (Figures 30 and 31) and other fishing banks. Stipulation b gives geographic locations for pipelines, rigs, platforms and any other development operation; type of disposal for drilling operations; and assesses impact of drilling operations. Stipulation c determines rig and platform location based on geophysical data and type of disposal for dilling operations.

We feel that these stipulations are adequate for protection of these banks from direct adverse impact. However, the potential for long term, indirect impact from drilling and production operations on such reefs and banks is insufficently known to allow prediction at this time.

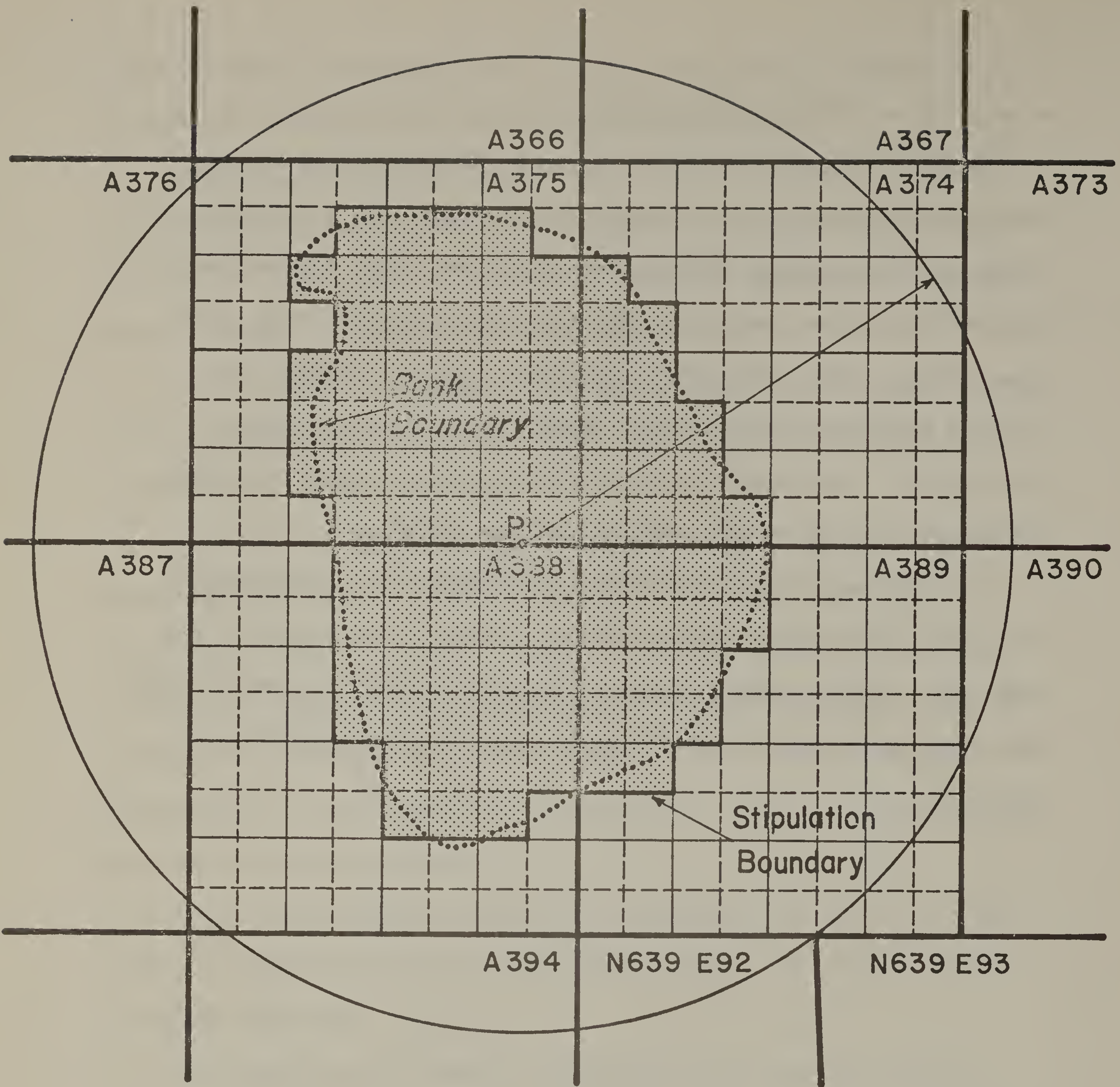



Figure 30. East Flower Garden Bank Area. Reef building coral is located in the central portion of the shaded area. Development operations, such as drilling, structures, or pipelines are not permitted in shaded areas. Development operations according to Stipulation No. 2 are permitted within the circle (radius = 20,064 feet around point P; located by X = 3,742,875, Y = 71,280; Texas Lambert System). Development operations in the white areas beyond the bank and circular boundaries are outside this stipulated area.

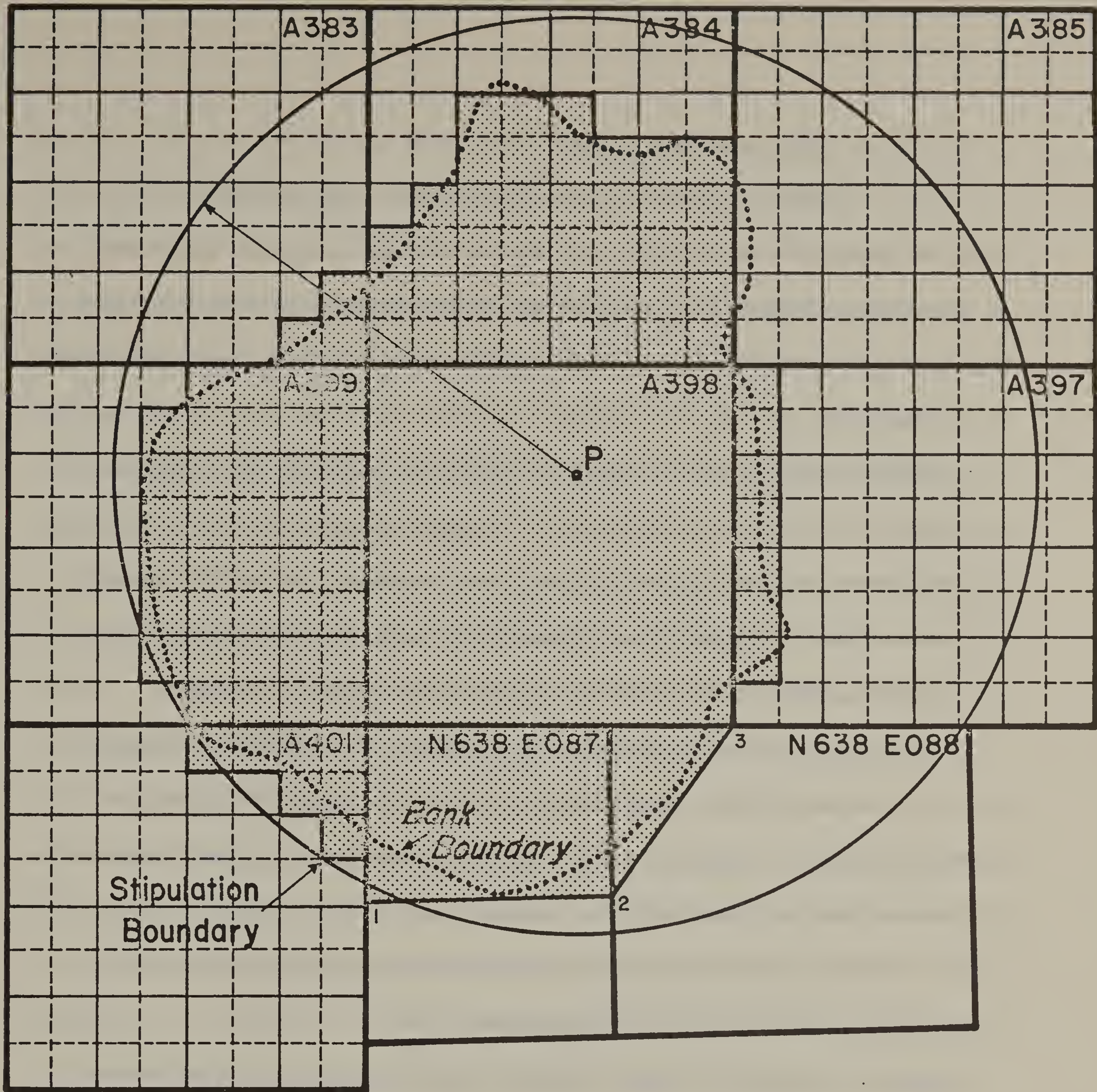



Figure 31. West Flower Garden Bank Area. Reef building coral is located in Block A-398 around point P. Development operations, such as drilling, structures, or pipelines are not permitted in shaded areas. Development operations according to Stipulation No. 2 are permitted within the circle (radius = 20,064 feet around point P; located by X = 3,674,965, Y = 50,690; Texas Lambert System). Development operations in the white areas beyond the bank and circular boundaries are outside this stipulated area.

5. Impact on Vegetation

This section will treat only that vegetation in the coastal area that may be effected by an oil spill from a lease tract or pipeline. This includes only the environments that are inundated regularly or periodically by tidal action that exposes the vegetation to pollutants.

Marsh vegetation is subject to impacts resulting from sporadic accidental oil spills, from chronic oil pollutants, and from pipeline construction. Tanker operations are not expected to result from this proposed sale. Therefore, accidental oil spills will be related to oil washed ashore from platform accidents or pipeline ruptures.

Numerous papers have treated the effects of a single oiling on emergent marsh plants. These reports discussed marshes located in several different regions of the world; however, the general vegetative groups are similar, and most are of the same genera. Thus, it is possible to draw from these studies some general conclusions as to how certain plant genera will be affected by oil.

Fuel oil spills at West Falmouth, Massachusetts and Chedabucto Bank, Nova Scotia, resulted in severe damage to many marsh organisms as reported by Burns and Teal (1971) and Thomas (1973), respectively. The plant most severely affected was the cordgrass, Spartina, a perennial plant that plays an important role in aeration, sediment, stability and nutrient recycling in marsh ecosystems, In the Chedabucto Bay spill, the heavily oiled areas showed virtually little recovering of Spartina after two years. This was due in part to the climate conditions which allowed for less

mobility of oil during the winter months, and for its remobilization during the warmer months. No cleanup was attempted; therefore, the detrimental effects on the biota were not compounded by the use of detergents, nor were they lessened by attempting to mechanically remove the oil. Little adverse effect on the other biota of the Chedabucto Bay lagoons was observed; however, the Falmouth spill reportedly affected all the biota, killing most of the vegetative species and showing a poor recovery rate.

Baker (1971a) reported on the oiling of single spillages in Milford Haven, England, and also experimental sprayings of marsh vegetation. Immediate effects included death of only the most heavily oiled shoots, followed by regrowth from living roots. During the recovery period there may be reduced germination and flowering, a reduced population of annuals, and growth stimulation of some species. The degree of damage appeared to depend significantly on the season of the year, with oiling during the growing season being the most damaging. In addition to the directly toxic or smothering effects of the oil on marsh plants, oil may interfere with the gaseous exchange between the soil and roots of plants and may affect flowering, seed production, and vegetation reproduction which subsequently may cause the vegetation to be set back for a seasons growth.

Cowell (1969) and Cowell and Baker (1969) investigated a crude oil spill at Pembrokeshire and Cornwell, England, respectively. While marsh vegetation had been killed initially, it appeared that most species had at least partially recovered a year following the spill.

Cowell also concluded that the time the oil had been in the water influenced the toxicity. The longer the oil remained in the water, the less toxicity it retained.

An oil spill in a coastal mangrove stand could be particularly damaging to the productive coastal ecosystem. This habitat type encompasses approximately 500,000 acres of the Florida coastline that is included in this proposed sale area (eastern Gulf, Graphic 4, Vol. 3). Also, the mangroves themselves would be susceptible to death should their aerial roots become coated with oil.

Less attention has been given to the subject of chronic pollution on the marsh enviroment. Baker (1971b), however, provided some data on this. In an experimental area in a marsh, test plots were subjected to oilings at various intervals. In general, recovery from up to four oilings was good, but above this resulted in a rapid decline of the vegetation. This tolerance varied some by different plant species. Baker also believed that marshes could probably survive two or three oilings a year, provided a long recovery period followed; or one or two light oilings with weathered oil per year for many years.

More insidious effects can be expected in areas of chronic pollution. Studies by Nelson-Smith (1973), Baker (1971b) and Crapp (1971) on the salt marshes of South Wales showed that refinery discharges,

even if in low concentration (10 ppm), will in a matter of a few years, because of its continuous flow over extended period of time, kill all the vegetation in the affected area. The damage to Spartina is caused by the accrument of oil on the surfaces of the leaves which prevent the transfer of oxygen within the plant tissues resulting in severe oxygen depletion around the roots. The killing of Spartina led to the subsequent erosion of the marsh and the loss of a portion (95 acres in the Nelson-Smith study) of the marsh habitat.

In general, there are many variables involved (oil type and amount, season of year, cleaning treatment and species of plant) that influence the degree that marsh vegetation will usually recover from acute oilings, with adequate recovery time, the possibility for serious short-term (less than one year) impacts to the marsh vegetation is possible in the event of an oil spill resulting from this proposed sale.

Due to the nature of this proposed sale, almost all tracts are located a considerable distance from shore and therefore pose little threat to marsh or upland vegetation. However, a few tracts located off the Texas and Louisiana coast are in close enough proximity that they could allow an oil spill or chronic pollutants into the marsh environment. These include Tracts 9, 10, 11, 40, 66, 69 and 71.

Adverse impacts to mangrove communities are also considered remote should this sale proceed. All tracts within this proposed sale area in the eastern Gulf are a considerable distance from shore. This fact plus the surface currents, evaporation, degradation, etc., make it highly unlikely that a major spill would reach a mangrove environment.

Gagliano (1972) has identified several adverse impacts to marshes as a result of pipeline canal dredging. These include primarily the disruption of marsh vegetation, salt-water intrusion, accelerated run-off and increased tidal exchange. Any of these impacts have the potential to reduce a marshes' productivity or alter the floral and faunal components. The duration can be expected to be short-term (less than one year) if the area is rehabilitated upon completion of the pipeline. However, impacts could result for several years if no effort at reclamation is made.

The extent to which an area's ecosystem may be influenced is partly dependent on the number and location of pipelines coming ashore, and the recovery of the right-of-way after completion. Generally, it behooves industry to utilize existing pipelines whenever possible which reduces expense and also unneeded disturbance to resources. From the estimated 20-50 platforms that may be generated as a result of this sale, 50-100 miles of pipeline are estimated to be required. In view of the distances of most of the tracts from shore, and after consulting with industry, it is anticipated that production from this sale proposal will be connected to existing facilities. Therefore, it

is estimated that the probability of pipelines coming ashore as a result of this sale is remote. Therefore, no adverse impact from construction activities will be incurred to marshes either immediately or cumulatively should this sale proceed.

Further discussion of the additional facilities that might be required should production be established in the eastern Gulf of Mexico area was included in section III.K.2. of the draft environmental statement.

6. Impact on Wildlife Species

Over 600 species of wildlife, either seasonally or permanently, inhabit the geographic area of the proposed sale area. These species utilize several coastal habitats but most are exposed directly to the marine environment in some way. It is not anticipated that any pipeline will come onshore from this proposed sale. A total of seven tracts out of 135 reflect possible environmental damage to refuges or beach areas by oiling.

Wildlife species in the coastal zone may suffer from a variety of impacts as a result of offshore leasing. Perhaps foremost is the loss of various marsh vegetation (habitat) that may result from an oiling. Since many species depend heavily on various ecological relationships, the removal of a particular segment could have serious consequences. As a result of habitat loss, several species would be forced to emigrate to other suitable areas either temporarily or permanently.

It is not anticipated that pipeline construction will occur in the marsh or upland areas as a result of this sale. However, if it occurred, it would be physically detrimental to certain species of wildlife, particularly the burrowing animals and species that may be nesting in the wetlands.

Numerous data are available concerning the impact of oil on various species of birds. There is little argument as to the serious or fatal consequences of birds contaminated with oil. With available data, it appears that birds generally suffer the same physical and physiological symptoms when contaminated with oil as other members

of their group. Therefore, mortality and damage to bird fauna as described by Bourne (1968) can be expected for those which have been coated with oil. Hydrocarbon contamination destroys the insulation and waterproofing ability of the affected plummage. Not only is the bird subject to heat loss and pneumonia in this condition, but also may lose buoyancy. In addition to the external effects, internal disorders can result from ingestion of the oil during preening or feeding.

Little is known concerning pelagic birds in the Gulf. Woolfenden and Schreiber (1973) state that the birds are apparently small in numbers and sparsely located. However, their observations were confined to the coastal Florida area. Menzies (1973) summarized 42 oil spills in the Gulf of Mexico over 50 barrels each, between 1964 and 1973. No indication of any bird losses were noted, although it is possible some loss may have gone unreported, since Clark (1973) reviewed several papers that suggested that less than 25% of bird corpses ever reach shore if killed at sea. Based on the above, in addition to the low probability of a large oil spill, this proposed sale should not adversely effect pelagic birds. But the possibility cannot be ruled out entirely.

Bourne (1968) discussed the probability of certain groups of birds being more susceptible to becoming oiled than others. He believed that aerial species would not deliberately dive into the oil and that coastal species may paddle over or squat in it on the shore but would receive minimal damage. It was suggested that swimming species were the most vulnerable since they would probably not notice the oil until they swam into it. The latter would include many of the

waterfowl group.

Shore birds (gulls, plovers, etc.) by nature spend a good part of their daily activities feeding and resting on the beach or shore environment. The effects of oil on shore birds has been documented by numerous investigators. Straughan (1970) and Drinkwater, et al. (1970) reported the impact of the Santa Barbara oil spill on bird life. Their data indicated that during an oil spill shore birds faired much better than some other groups of birds closely associated with the marine environment. From mortality figures on 432 birds, less than 20 were classified as shore birds.

In addition to the effect of physical contact with oil, Hartung and Hunt (1966) investigated the impact of oil ingestion by waterfowl. It was determined that lethal doses of lubricating oil ranged from 1 ml. to 4 ml. per kilogram of body weight. Therefore, a duck that acquired a coating of seven grams of oil and preened about 50 percent of this could easily ingest a lethal quantity. A definite correlation cannot be made concerning the relationship between the lubricating oil and crude found in the Gulf of Mexico. However, it is presumed that sufficient quantities of ingested crude would cause death. The probability of this cannot be estimated, however, in reality the chance of this occurring is considered low.

External effects of oil are not the only detrimental impact possible to birds. Hartung (1965) demonstrated that duck eggs treated with 2-36 mg. of medicinal oil (presumably non-toxic) indicated a hatchability of 20 percent as against 90 percent in controls. Also,

of 19 eggs incubated by ducks smeared with oil on their undersides, none hatched. Ingesting oil-contaminated food also halted laying and suppressed reproductive behavior. Rittinghaus (1956) reported an incident in which the eggs of numerous terns and other shore birds failed to hatch after the parents had become contaminated with oil.

The possibility does exist for significant damage to occur to marsh and shore birds should an oil spill reach the shore and contaminate the birds or their habitat. In view of the distance from shore that most of the oil prone tracts are located, this possibility is significantly reduced. However, seven tracts (9, 10, 11, 40, 66, 69 and 71) are close enough to shore that they could pose a threat to nesting birds should an oil spill occur.

Indirect impacts to shore and marsh birds could include temporary loss of habitat due to pipeline construction, and permanent loss due to the construction of onshore facilities. This impact is also felt to be improbable since no new refineries are anticipated and most, if not all, new production from this sale will come ashore in existing pipelines. Therefore, no impact will be incurred.

Literature review reveals little work on the effects of acute doses of crude oil on mammals or other species inhabiting marsh habitats. Peller (1963) and Wragg (1954) observed various oilings of muskrats and beavers. Generally, the insulating properties of the fur of aquatic mammals can be expected to be destroyed upon being coated with oil, later resulting in illness or death.

Nelson-Smith (1973) stated that since mammals have an impervious

skin and breathe air, that opportunities for toxic components of oil or emulsifiers to exert a physiological effect, are largely limited to their ingestion during preening, grooming, and perhaps feeding. Irritation of the eyes or exposed mucous membranes may also be common to contamined individuals.

In view of the general proposal of this sale, the probability is considered remote that an oil spill with reach shore. However, seven tracts (9, 10, 11, 40, 66, 69 and 71) are in close enough proximity that an oil spill could reach shore and create an adverse impact to the wildlife species.

Data are not available from the Gulf of Mexico to estimate the impact of offshore production on marine mammals. However, the impact would appear to be a function of the probability of an oil spill and the population size and distribution of the species. Therefore, it is improbable that leasing will effect marine mammals in the Gulf to any extent. These species do not appear to be abundant in the Gulf which reduces their chance of exposure to oil contamination.

7. Impact on Endangered Species

Several endangered species inhabit the coastal zone of the Gulf of Mexico (Graphics 4, Vol. 3). This discussion will treat only these species classified as "endangered" by the U.S. Department of the Interior. However, the numerous species listed as endangered by state agencies will receive equal consideration should offshore production related activities effect their habitat. These will be covered in separate environmental analyses should the need arise.

The manatee's distribution in the Gulf has changed little in recent years and peninsular Florida remains the focus of the species range. The populations tend to concentrate in select estuarine and river habitats that provide adequate vascular vegetation, recourse to warm water, a source of fresh water and proximity to channels of at least two meters in depth.

The primary adverse impact to the species that could occur from offshore leasing is that of habitat destruction through water pollution and possible pipeline laying operations. However, pollution from a lease site is considered remote due to the distance the tracts are from the estuarine areas. Also, it is expected that the currents would considerably dissipate an oil slick before it reached the manatee's habitat. No new refineries are anticipated in this area, therefore pollution from this source is not expected.

In summary, the potential for offshore leasing and related activities impacting on the manatee or its habitat is considered remote should this sale proceed.

The Okaloosa darter is restricted to several small streams that empty into Choctawhatchee Bay near Niceville in Okaloosa and Walton counties, Fla. The species is found in small to medium sized streams with clear water, moderate to swift current and with clean, sandy bottoms or with a thin mud and detritus overlay.

The principal impact from offshore leasing that could effect the darter is that of habitat destruction from pipeline or onshore facility construction. However, in view of the proposed construction expected if this sale proceeds, it is unlikely that this impact will be realized. No effect is expected to the darter from the OCS sale if it is implemented.

With the exception of isolated populations the brown pelican has been basically extirpated from the central and western Gulf and is now primarily concentrated along the Florida coast, both as a breeding entity and general distribution. One colony exists near Grand Terre Island, Louisiana and two small groups breed on the coast of central Texas.

Possible impacts on the bird as a result of offshore leasing include the possibility of becoming contaminated with oil, ingesting oil-contaminated food and possible nesting and/or habitat disturbance from pipeline construction. Since this species does depend totally on the marine environment, the possibility of it becoming oiled or ingesting oiled food organisms must be considered in the event an oil spill does occur in close proximity.

All of the proposed tracts that may contain oil that

could effect the pelicans of the Florida coast are located beyond 25 miles from shore. With the contingency cleanup equipment and distances from shore, the chances of oil impacting the birds or their habitat is considerably reduced. It is not expected that an occurrence of this nature would be immediately detrimental to the entire population of the state since it is widely distributed along the coast. Any pelican that did contact the oil would, however, be susceptible to illness or death and any loss could conceivably contribute to reducing the population. There are no tracts in close proximity to the populations in Louisiana and Texas. No impact is anticipated to these populations.

The possibility for consuming oil-contaminated food organisms is a possibility since the pelican feeds on fish species. No data is available concerning single or accumulative internal doses of petroleum derived hydrocarbons on these birds. However, a massive dose would surely have some adverse impact. The possibility of this impact is considered remote since all the tracts that may contain oil are beyond the pelicans normal feeding range which is generally near shore.

It is not believed that pipeline construction resulting from this sale will have an adverse effect on the species other than one of possible disturbance should construction near their habitat occur.

The southern bald eagle maintains several nesting sites in coastal Florida as well as scattered sites along the coast of Louisiana and Texas. The eagles are susceptible to nest site destruction,

and the ingestion of oil-contaminated foods.

The possibility of nest site destruction and/or harassment during nesting should not result from offshore leasing should this sale proceed. Nesting sites are located and mitigatory measures can be applied to any onshore developments that may result. Also, no new development is anticipated from this proposed sale.

Consumption of oil-contaminated fish is a possibility since a large part of the bald eagle diet is fish and fish of the estuarine zone could be exposed to chronic pollution or possibly an oil spill. However, it is not apparent at the time that petroleum hydrocarbons are physiologically affecting the eagle population.

Several colonies of the red-cockaded woodpecker have been identified in the coastal areas of the Gulf with the most significant populations occuring in Florida. Since this species is a resident of mature pine forests, it is somewhat removed from offshore leasing. The primary impact from offshore leasing would be habitat destruction. Since no onshore developments are anticipated from this sale, this impact is not expected to be realized, therefore, no adverse impact to the species will occur.

Alligators for all practicable purposes are coastal wide throughout the geographic area of this proposed sale. They are primarily a species of the fresh water environment, but occasionally inhabit brackish marshes. It is not expected that acute or chronic discharges of oil will reach their habitat should this sale proceed. The ingestion of oil-contamined species is a remote possibility, but if it

did occur, it is not expected that this would prove very detrimental for any length of time and would not affect the population as a whole.

The possibility of habitat destruction by allowing salt-water intrusion into the fresh water environment is also possible. However, this would be on a local basis and would not affect the total population to any extent. It is not anticipated that this proposed sale or the cumulative result with previous leasing will result in any adverse impact to the alligator or its habitat.

Endangered sea turtles in the Gulf include the Atlantic ridley, leatherback and hawksbill. The principal impact that may effect the turtles as a result of offshore leasing is oil washing ashore and possibly contaminating the eggs or hatchlings. This possibility is remote, however, since there are no tracts in a position to be of potential danger to the nesting areas. Individual turtles could be coated with oil if they emerged into an oil slick. But this also would be a remote possibility. Leasing as a result of this sale should not adversely effect the sea turtle population on a cumulative or immediate basis.

The red wolf inhabits the coastal prairie in southeast Texas and southwest Louisiana. Habitat disturbance associated with onshore inducements from offshore leasing is the main potential impact that could occur. This is not likely to happen from this sale as there are no new

onshore developments anticipated in this region. However, further urbanization of the area plus the increased hybridization with other canids could eventually lead to extirpation of the species.

8. Impact on Commercial Fisheries

Offshore oil and gas operations interfere with commercial fisheries in the following ways: removal of sea floor from use; underwater obstructions; oil pollution (chronic or accidental); pipelines and reefs (man-made and natural).

a. Removal of sea floor from use

This impact involves navigational problems to commercial fishing fleets and reduction in the area of fishable sea floor. Since the majority of shrimp and commercial bottom fish are caught by dragging large trawls across the sea floor, sites occupied by drilling or production platforms and attendant service boats and barges must be avoided. If the structures are jack-up drilling rigs or permanent production platforms, the area of the sea floor removed would amount to two to five acres for each structure. In deeper waters (over 300 feet), a semisubmersible drilling rig with its anchoring system would occupy up to 162 acres (assuming a 1500 foot anchoring radius). Trawling depths range from approximately 30 to 270 feet; therefore, structures beyond the 270 feet depth would have a minimal impact on trawling operations. The duration of exploratory drilling ranges from approximately 45 days for a single well to around six months for multiple well explorations. Permanent production platforms may remain in place for 10 to over 20 years.

The probability that permanent platforms will be erected on any leased tract, based on past exploration success rates, is about 32% for offshore Louisiana between October 13, 1954 - June 13, 1967.

Approximately one out of three tracts will require a platform (or platforms). It is estimated that each full tract (5,760 or 5,000 acres) developed will average two platforms. Using the actual dimensions of a platform, two per tract would physically cover approximately 0.02% (1.0 acre) of each tract's sea floor. Taking into account a navigational safety zone around each structure and using the 2 to 5 acres per platform figure, trawlers may be denied up to 0.2% (10 acres) of the sea floor per developed tract assuming two platforms are erected. The number of new platforms expected from this sale ranges between 20-50 therefore, the maximum number of acres denied fishermen would be 250 acres for the duration the platforms are in place. Location and water depth of these platforms is unknown (i.e., placement on shrimp grounds); however, stipulation #1 in Sec. IV,D., concerning the limiting of structures will be considered when planning the placement of structures. In this manner, fishing interests at any particular proposed development site can be considered in detail on a case-by-case basis. In addition, offshore rigs and platforms present navigational problems to fishermen. Boats engaged in trawling will be inconvenienced by having to navigate around fixed structures and there exists the possibility of fishing boats colliding with structures.

A Coast Guard summary for the period July 1, 1962 through June 30, 1973 reported ten collisions of fishing boats with offshore structures. Causes of these collisions were personal neglect aboard fishing boat (5), equipment failure on boat (1), equipment failures on rig (3) and insufficient and improper lighting of rig (1). There was only one injury, total damage to boats amounted to $151,000 and damage to platforms $24,000.

It is obvious that commercial trawling may be adversely affected to some degree for the next few years because of reduction in trawable grounds; however, the extent of this is not know but will be more cumulative in nature. There are no data to indicate that offshore exploration is responsible for any decline in catches at present. There is reason to expect that with an increase in the number of platforms, the chance for increased fishing boat collisions with these platforms will result; however, this is unquantifiable.

b. Underwater obstructions

Underwater obstructions or completions have little ecological importance but may cause problems to trawlers. The obstructions referred to here are underwater stubs and large pieces of debris which when snagged, may cause damage to trawls and nets. Underwater obstructions also include submerged well heads.

The source and nature of underwater stubs is described in Appendix D. 3. As previously stated, Coast Guard regulations require that stubs be marked by a lighted buoy at the surface if there is less than 85 feet of clearance. Stubs with clearance of between 85 and 200 feet must be buoyed; however, a lighted buoy is not required. These buoys are frequently missing despite regular maintenance and replacement. Also, if in water depths of 85 to 200 feet, the stub is covered by a bonnet, then it need not be marked by a buoy.

Another safeguard has been the plotting of these stubs on navigation charts for vessels with accurate navigational equipment.

In addition Loran-A (navigation instrument most used by fishermen) readings have been recorded and published in numerous publications. Fishermen use these readings to avoid areas where stubs or obstructions may be located.

Large pieces of debris, such as equipment, piping, structural members, tools and the like, may accidentally be lost off a platform, service boat or barge. If this occurs near a platform it may be located by divers and retrieved as specified in OCS Order No. 8. However, it it is lost from a boat or barge underway, the location may not be known accurately enough to allow its subsequent recovery.

The number of underwater obstructions is unknown; however, stipulation No. 1 in Sec. IV, D., concerning the limiting of structures is considered when planning the placement of structures. In this manner, fishing interests at any particular proposed development site can be considered in detail on a case-by-case basis.

c. Oil pollution (chronic and accidental)

St. Amant (1974) stated that chronic pollution from offshore production sites represents an unknown factor. Daily drips and loss of small amounts of oil or other chemicals overboard do not appear to generate ecological problems because of the immense water volumes compared to the small amount of oil lost. Whether such sublethal pollution levels will eventually accumulate and cause environmental degradation is yet to be determined.

Dr. J. R. Thompson, investigating for the Gulf Universities Research Consortium (1974), found no evidence to indicate either harmful or beneficial effects of the placement and maintenance of offshore oil platforms on the bottom fisheries on the open shelf. His study included the most abundant bottomfish trawl fauna of the north central Gulf of Mexico, between longitudes of 89° 30' N. and 92° 30' W., and 10-75 fathoms across the Continental Shelf off Louisiana. Dr. Thompson used data from the work of the Bureau of Commercial Fisheries (now National Marine Fisheries Service), with the M/V Oregon and chartered vessels from 1950-65. This period saw the rise of the offshore oil industry in the study area. Dr. Thompson also stated that no trends were apparent through the period in either quantity or distribution of species studied.

Dominant fishes for the study included croaker, spot, scup, cutlass fish, sea catfish, sea trout, ground mullet and lizard fish. Dominant invertebrates included offshore blue crabs and the brown and rock shrimps.

In an area of a chronic oil spill, commercial fishing activities are inhibited in order to avoid contamination of fishing equipment, vessels and catch. Also long term deleterious effects could result.

There are three particularly important ones, impossible to quantify. (1) If large amounts of plankton were destroyed the food web could be seriously disrupted and result in population crashes of organisms directly or indirectly dependent upon the plankton. (2)

Entire year classes of juvenile or larval fish might be destroyed resulting in greatly reduced yields several years after the spill. Ketchum (1973) refers to Mironov's work in 1967, stating there was 100% mortality in developing flounder spawn at concentration, ranging from 1-100 ppm in three types of oils. (3) Oil pollution might lower organisms' resistance to disease and other environmental stresses. This could produce less robust, lighter weight individuals and an increased mortality rate over a long period of time, causing a slow, but marked decline in fisheries. Ketchum (1973) showed that abnormal development occurs following longer periods of exposure to concentrations as low as 0.01 ppm. (4) Fish may have to be discarded due to tainting of the flesh. One example was given by Connel (1971) who stated that the Australian mullet had a kerosene-like tainting due to the presence of kerosene-like hydrocarbons in the flesh. He found the contaminated compounds to be similar to substances isolated from river sediments. The river used by the mullet flows alongside oil refineries and associated storage and wharf facilities. Volatile hydrocarbons were found in the water adjacent to petroleum storage facilities and also in the river's estuary near a sewage fallout. Sea-trout and plaice were found to be tainted according to taste test. These fish were caught after the _Torrey Canyon_ incident involving the spillage of Kuwait crude oil. No chemical analysis by chemical class was reported (Clark, 1973).

Numerous studies on the effects of oil on commercially important shellfish indicate that these invertebrates may both absorb, and to varying extents, clean themselves of hydrocarbons.

Oysters (Crassostrea virginica) may accumulate oil through feeding activity in a pollution zone. As the oyster feeds, it pumps water over a series of gill filaments which trap food particles such as phytoplankton. Hydrocarbons in the plankton may be incorporated in the oyster. Ehrhardt (1972) reported that oysters taken near the entrance to the Houston Ship Channel in Galveston Bay, Texas are contaminated with a high content of petroleum derived hydrocarbons. Becuase aromatic hydrocarbons are more soluble than paraffinic and naphenic hydrocarbons, the oysters most likely take up the aromatic fraction as a water solution through their gills, and as filter feeders by accumulation of particulate food matter. The author found the composition of oyster contaminants to be similar to many Texas crude oils, among them Conroe, Beaver Lodge, and Lee Harrison crude.

Results from Blumer's (1971) study on more highly aromatic #2 fuel oil rather than on crude oil suggest that oil becomes part of the organism's lipid (fatty) pool. Blumer noted that the oil in specimens observed from a Massachusetts oil spill remained relatively unchanged in composition or quantity. He reasoned that if the oil were localized within the digestive tract, a shellfish could eliminate it rapidly. But the persistence of the hydrocarbon over a time period of six months, its presence in adductor muscle tissue and the lack of further degradation of these hydrocarbons indicated that it becomes part of the organism's lipid pool.

Anderson (1973) observed oysters (*Crassostrea virginica*) and clams (*Rangia cuneata*), exposed to south Louisiana crude oil and to #2 fuel oil, and came to a different conclusion. Anderson found that both aromatic and saturated hydrocarbons are released from the tissues more rapidly; maintenance in clean water for periods of 24 to 52 days was reported sufficient to cleanse the tissues of detectable levels of hydrocarbons.

Teal and Stegeman (1973) measured the amount of hydrocarbons remaining in contaminated oysters after their return to clean water and found that a concentration of 34 mg/g wet wt. persisted in a "stable" compartment. The authors concluded that, while the oysters would not retain non-biogenic (petroleum) hydrocarbons permanently, complete removal would take a "considerable amount of time".

St. Amant (1973) reported that under field conditions, oily tastes generally occur in oysters when the substrate exceeds 500 ppm of hydrocarbon. He said "that if the oysters are removed to unpolluted areas and allowed several months of depuration, they will eventually purge themselves of oil to a point where noxious tastes are not detectable." This of course, does not assure the absence of all petroleum hydrocarbons.

Scarratt (1971) has found that commercial species of scallops ingested spilled Bunker C oil. Subsequent chemical analysis revealed the presence of Bunker C in the mantle, digestive gland, adductor mussel and gonad.

Studies on the effects of petroleum hydrocarbons on shrimp are few. St. Amant (1973) referred to a concentration of oil of 10 ppt as being lethal to these organisms. He added, however, that to reach this concentration under field conditions, more than 3,000 gallons of oil per acre foot of water would be required to meet the concentration. This concentration is rarely acquired except in the immediate area of a spill.

In summary, we feel that oil spills could have both short and long term impacts on commercial fisheries; however, no measurable affects have been observed for chronic or accidental spills of oil. Oil spills may physically prevent fishing in contaminated areas. Adult fin-fish are not normally killed outright, but possibly could suffer a long term decline due to lowered resistance to disease and environmental stress. Larval and juvenile fish could be killed in great numbers if a spill reached spawning or nursery grounds (i.e., estuary). Many fish not destroyed may be tainted with hydrocarbons and be unmarketable. Shellfish are more susceptible to contamination because of their inability to escape and their general filter feeding habits. Many larval and juveniles could be killed outright. Survivors could be tainted and unmarketable for long periods. Authors disagree on the time required for shellfish to

cleanse themselves. Estimates vary from several months for complete depuration to six months with no depuration.

Additional discussion on the impact of oil on fisheries may be found in Section III. A. 2 and 3 (benthos and nekton). These sections also contain discussions on the impact of drill mud and cuttings associated with drilling operations.

d. <u>Pipelines</u>

BLM is presently conducting a thorough search for data pertinent to a better understanding of the problems of anchor and fishing gear hangups on pipelines. Reliable data relevant to this problem are needed to help determine what burial depths are sufficient to prevent damage. BLM through its permit authority, requires pipelines to be buried a minimum of three feet out to a water depth of 200 feet. Beyond this depth, pipelines are not required to be buried or marked by lighted buoys. Spokesman for the offshore pipeline industry indicate, through their experience in the installation and attempted maintenance of lighted and unlighted buoys, that a marker system in deeper water is extremely difficult to maintain. Heavy seas damage the buoys and their gear, and if sufficient slack is allowed to combat heavy wave action, then the buoy will not closely indicate the location of the pipeline. Compounding the problem is the history of alleged pilferage and vandalism which shortens the useful life of these markers. In any event, the data necessary for a determination as to the scope and significance of potential damage to fishing gear resulting from unburied and unmarked pipelines beyond 200 feet in depth has not been

forthcoming from either the fishing industry or any government source. Snow (1974) in outlining the pipeline policy of the Louisiana Shrimp Association states, "It is our opinion, and recommendation, that within the 200 foot contour, all pipelines should be buried".

Furthermore, because of the small number of pipelines planned for this proposed sale, and the slight risk of a snag presented by a pipeline, the costs involved in burial or marking of pipelines beyond 200 feet far outweight the benefits. In addition, valves and taps are buried beyond 200 feet. Presently under development by National Ocean Survey and BLM is a program to chart all major offshore pipelines and flow lines. Several charts for regions of the Gulf of Mexico have now been issued. Hopefully, fishermen in the Gulf will find these charts useful.

Concerning the matter of pipelines traversing the least amount of estuarine habitat, BLM, before issuing the permit for right-of-way for any common-carrier pipeline, coordinates extensively with appropriate state authorities and conducts an environmental assessment of the proposed route to determine whether an environmental impact statement should be prepared. In addition, should exploratory drilling reveal sufficient reserves to warrant new pipeline landfalls, BLM will participate with the affected states in conducting pipeline corridor studies.

Kilegen and Harris (1973) studied the mariculture potentials in estuarine oil-pipeline canals and reported that many of the closed-off canals in estuarine areas can be managed to produce annual crops of fishes and shellfishes of commercial and recreational value. Some canals have yielded high standing crops of several fish

species, and crabs. One of the most promising management techniques is that of using cage culture for a commercial fish species, such as channel catfish or pompano. This method of fish culture eliminates problems of predation, flooding of canals and harvesting. Sport fishes, such as speckled trout, red drum and others, with forage species, could be stocked and managed in the same canals. Another alternative would be to stock shrimp or oysters in canals, with fish raised in cages. The shrimp would eat waste material from under the cages, and oysters, grown on racks, would filter out algae and other foods from the canal waters. This system would provide maximum benefits from a relatively unused resource, increasing its commercial value by several hundred dollars per hectare. For these reasons, it is imperative that research be continued towards development of canal fisheries management techniques, so that these valuable resources will not be lost.

As previously stated, the miles of pipelines expected from this sale are 50-100. Locations of these pipelines are unknown; however, it is expected that the majority of them will be utilized to transport oil and gas to common-carrier pipelines offshore.

e. Reefs (man-made and natural)

Man-made reefs (in this instance) refer to those reefs created by the placement of platforms. These platforms serve as a haven and shelter for many types of fishes and invertebrates, mainly fouling organisms, GURC (1974) investigation reported these findings concerning the biomass associated with these structures: The platforms are the site of marked increase in biomass due to the "reef effect", over one to two orders of magnitude higher than other biotopes (Table 71). Components of this increase are the fouling community and the fishes they attract which are responsible for this portion of the economically important sports and commercial fishery. A discussion on fishing banks may be found in Section III. A. 4.

Table 71. Biomass Determinations

| | Timbalier Bay | 54A The Platform | Offshore Controll |
|---|---|---|---|
| Organic Carbon, in water | 8.3-14.5 gm/$m^3$ | 5.8 gms/$m^3$ | 5.1 gm/$m^3$ |
| Hydrocarbons in water 1/ | 6.2 mg/$m^3$ | 3.3 mg/$m^3$ | 1.2 mg/$m^3$ |
| Hydrocarbons in surface film | not studied | 0.21-1.27 mg/100 grams | 0.21-1.27 mg/100 grams |

(continued)

1/ Hydrocarbons from all sources, including petroleum, organic detritus, plankton, etc.

Table 71. (continued)

| | Timbalier Bay | 54A The Platform | Offshore Control |
|---|---|---|---|
| Hydrocarbons in sediments | 161-341 mg/100 grams | 145-412 mg/100 grams | 145-412 mg/100 grams |
| Primary Productivity 2/ | not studied | 1.07 gms/ $m^2$/day | 1.03 gm/ $m^2$/day |
| Amphipods | 8.75 gm/m2/ | 24.2 gm/m2/ | 17.7 gm/m2/ |
| Zooplankton | 0.02-0.2 gm/$m^3$ | 0.3 gm/$m^3$ | 0.3 gm/$m^3$ |
| Polychaetes | 0.3-5.0 gm/m2/ | not studied | N.A. |
| Platform growth | N.A.3/ | 3000 gms/m2/ pile surface | N.A. |

2/ Substantially higher offshore Louisiana than other regions investigated in the open Gulf and offshore Florida.

3/ N. A. - Not Applicable.

B. Impact on Air Quality

The quality of air over the sale area could be degraded by several types of sources including exhaust emissions of stationary power units, service vessels and by the accidental release of oil and gas from wild wells.

An average composition (Levorsen, 1967) of natural gas from an on-shore field in Texas (an offshore field would be similar) is as follows: methane 92.5%, ethane 4.7%, propane 1.3%, butane 0.8%, and pentane and heavier 0.6% (small amounts of sulphur are usually present).

If a blowout occurred at a gas well and was not burning, obviously, the above gasses, in a comparable ratio, would be released into the air. A typical Texas offshore well produces approximately one million cubic feet per day of gas. A blowout could reasonably be expected to release at least this much gas into the atmosphere. However, if the gas well was burning, combustion would be essentially complete and the emissions would consist almost entirely of carbon dioxide ($CO_2$), water and any sulfurous gasses would be oxidized to $SO_2$. It is not possible to predict the possibility of this occuring since essentially all of the components of natural gas are non-reactive, there would be little impact whether or not they are burned. Therefore, recovery of this resource for use as a fossil fuel could result in a positive impact in some areas by providing energy by the cleanest source to be utilized, thus helping to alleviate air pollution.

If a blowout at an oil well occurred and was releasing crude oil into the water, the resulting impact would be substantially greater, and the various impacts discussed in Section III.A. may be incurred. If the oil does not burn, a significant amount of it will evaporate. During the Chevron, 1970, spill, it was estimated that 15% of the roughly 30,000 barrels (bbls.) spilled evaporated. At an average density of 310 lb/bbls, this incident would have introduced almost 14,000 lbs of hydrocarbons into the air. Some oil spills in the past have resulted in fires, however, the chance of this occurring is minimal. If in fact this were to occur, emissions from the crude oil would be relatively low in reactive compounds.

A reasonable estimate of the range of emissions, assuming complete combustion, that an oil well fire could produce per 1,000 bbls burned, might be as follows (Levorsen, 1958): $CO_2$ : 340,000-347,000 lbs., $SO_2$ : 620-34,000 lbs ($SO_2$ emission would be less for Gulf of Mexico crude oil, which range from 0.1 to 0.5% sulfur), and NO : 660-10,000 lbs.

Combustion of oil would in reality be incomplete, however, and emission would contain somewhat less of the above compounds, but would include, in addition, such materials as volatilized petroleum, particulate carbon, carbon monoxide, nitrous oxide, sulphur monoxide, along with other altered or partially oxidized matter. There is no reliable way to predict in advance the relative volumes of each of these possible emissions because it would depend, among

other things, upon moisture content of the air, wind speed, pattern of oil spray from wild wells, number of wells involved, chemical content and physical character of the oil itself, and types of equipment and materials other than oil that might also burn.

Massive spills from wild wells are not the only source of spilled oil. A number of minor spills during the first nine months of 1972 released over 800 barrels of oil. The net result is that a small amount of spilled oil is floating somewhere on the waters of the Gulf of Mexico almost continually. The evaporation of this oil may cause elevated levels of hydrocarbons in the sea breeze coming off the Gulf. At the present time there is no evidence as to the source of these materials.

An increase in refinery capacity will add to the total emissions of oxides of nitrogen, sulphur dioxide, hydrocarbons, carbon monoxide, hydrogen sulfide and particulates affecting air quality onshore. An increase in refinery capacity and other petrochemical industries to process the predicted production resulting from this sale of up to 120,000 barrels per day would cause a small increase in emissions. Oil produced as a result of this sale, however, may not necessarily create the need for increased refinery capacity and other petrochemical industries; it may replace oil that otherwise would be imported or it may take the place of oil that will not be furnished from domestic sources due to declining production or other factors. In summary, it cannot be accurately predicted to the degree that air quality will be deteriorated from refinery use by production from this sale.

Because of the distance of most of the tracts from shore and the normal sea breezes, the impact of exhaust emissions is considered negligible, should this sale proceed.

If a large oil spill were to occur air pollution degredation onshore could occur. Specific results can be found in Sale 35 EIS for the Southern California leasing program.

C. Impact on Water Quality

During drilling and oil production the water quality of the Gulf may be altered and degraded in several ways. Many of the chemical and physical factors which will be transferred to the Gulf during various phases of oil production will represent potential hazardous water quality parameters. These potential hazards of degraded water quality may be found to be insignificant or significantly adverse. The magnitude of many potential hazards should be answered by future research.

On September 15, 1975, the EPA published in the Federal Register (40 CFR 435) a notice of interim final effluent limitations guidelines and new performance standards for offshore segment of oil and gas extraction point source category. It is indicated that the major source of waste waters generated by offshore facilities are produced waters. The effluent limitations guidelines for the offshore segment of the oil and gas extraction industry are concentration based as opposed to a mass per unit production base. The major pollutant formations in the waste waters resulting from the oil and gas extraction industry are oil and grease, residual chlorine, and floating solids. The water insoluble hydrocarbons and free floating emulsified oils.

For waste water from produced waters several methods of treatment technology may be employed to achieve final limitations. It is also noted that drilling muds and drill cuttings may be discharged if they are water based and their discharge does not result in free oil on the

surface waters. Muds and cuttings that are oil based may not be discharged, and by 1983 new source performance standards will require no discharge of waste water pollutants to navigable waters for wastes generated by produced water sources of this subcategory.

Limitations have established the quanity or quality of pollutants or pollutant properties, which may be discharged by a point source subject to the provisions of the EPA statement. After application of the best practicable control technology currently available the following limitations are to be considered:

Effluent Limitations

| Pollutant parameter waste source | Oil and grease: Maximum for and 1 d, milligram per liter | Oil and grease: Average of daily values for 30 consecutive days shall not exceed milligram per liter | Residual chlorine minimum for any 1 d, milligram per liter |
|---|---|---|---|
| Produced water | 72 | 48 | NA |
| Deck drainage | 72 | 48 | NA |
| Drilling muds | (1) | (1) | NA |
| Drill cuttings | (1) | (1) | NA |
| Well treatment | (1) | (1) | NA |
| Sanitary: | | | |
| M10 | NA | NA | [2] 1 |
| M9IM[3] | NA | NA | NA |
| Domestic[3] | NA | NA | NA |
| Produced sand | (1) | (1) | NA |

1 No discharge of free oil.

2 Minimum of 1 mg/l and maintained as close to this concentration as possible.

3 There shall be no floating solids as a result of the discharge of these wastes.

Sewage will be treated in accordance with OCS Order No. 8, which requires the treated effluent contain less than 50 ppm of bio-chemical oxygen demand (BOD), less than 150 ppm of suspended solids and a minimum of 1.0 ppm residual chlorine after a rentention time of fifteen minutes. Treated sewage of this type which has proper discharge diffusion should produce a minimum amount of water quality deterioration.

To some degree, bottom sediments would be put into suspension by the emplacement of re-entry collars, blowout preventors, drilling platforms and other sea-bottom equipment. The magnitude and extent of resultant turbidity would be dependent on the type and grain size of bottom materials, the prevailing water current and the duration of the activity. Proposed lease areas should have a short term impact from resultant temporarily increased turbidity.

Water quality degradation is also effected by resuspension of sediment during pipeline construction and burial. The jetting away of the substrate from beneath the pipeline will result in suspension of sediments which may be rich in pollutants. The sediment plume will move away from operations in the direction of the current. The plume can reach proportions of several yards wide and hundreds of yards long if the substrate is exceptionally muddy. The duration depends on the particular size, shape and density of the material suspended and the water's trubulence. After construction, normal pipeline operations will have no effect on the water quality. Adverse

long-term impacts can result when pollutants are resuspended in the water column.

During drilling operations, drilled cuttings may be discharged into the Gulf. Most cuttings will consist of sandstone and shale fragments; however, some silt and sand size cuttings may be produced and discharged into the water. We estimate that 1,700 barrels of cuttings may be discharged during the course of drilling an average 10,000 foot well over a period of ten to fourteen days.

Drilled cuttings discharged into the Gulf that could contain drilling mud if not properly washed, would be dispersed and fall to the Gulf floor. The accumulation density on the Gulf floor and the degree to turbidity resulting from drilled cuttings will depend on the current and the water depth in the area of discharge. The increase in turbidity will present a short-term decrease in the water quality. This impact will be of low magnitude.

Drilling muds that are used during drilling operations will be discharged periodically or accidentally into the Gulf. No detailed studies have been made on the manner in which drilling mud chemicals and drill cuttings may contributed to pollution in the marine environment. However, water base muds, cuttings and other waste fluids can be considered pollutants when waste treatment is not utilized. Possible pollutant characteristics include: acute toxicity to fish; high immediate dissolved oxygen demand; and high concentrations of organic carbon, total nitrogen, phosphorus, solids, chemical oxygen

demand and chromium.

The production and discharge of formation waters (oil field brines) has been discussed earlier. Three components or properties of formation waters contribute to water quality degradation when released into the Gulf. These include: entrained liquid hydrocarbons; dissolved minerals salts; and absence of dissolved oxygen.

Depending upon the formation from which an oil field is producing, dissolved elements and their respective concentrations in formation water may differ. However, the components of each reservoir will usually remain constant unless leakage occurs from one reservoir to another.

Wells that are in initial state of production may have formation waters which represent 20-30% of the total extractable fluid. As the oil reservoir is depleted the amount of formation water increases. The maximum amount of formation water produced during the life of oil production will be approximately 0.6 barrels of formation water per barrel of oil produced.

To determine water production, the peak oil production is multiplied by the maximum water to oil ratio. The maximum water to oil ratio doesn't occur during periods of peak production. The water to oil ratio should be less than one during peak production and near one toward the end of the primary production period.

Within the proposed lease area the maximum oil production is estimated to be 100-300 million barrels of oil. This would be extracted over a twenty year period. The expected annual production of oil will be from 21.9 - 27.4 million barrels. Considering the

maximum amount of formation water production (0.6 barrels of formation water per barrel of oil produced), approximately 13 to 16 million barrels of formation water per year will be produced providing all the tracts are leased and developed.

In the Gulf of Mexico many platforms are disposing of treated formation waters where the treatment equipment puts out an effluent less than 25 ppm oil content, but many older platforms are not accomplishing this. Other locations only manage to meet the requirements of OCS Order No. 8, releasing waters with entrained oil averaging less than 50 ppm. The range of oil concentrations discharged from surveyed production platforms in the Gulf ranged from 6-827 ppm (EPA, 1974).

Due to many factors which will contribute to the physical and chemical characteristics of formation waters, no estimate can be made to the extent of the impact from these waters. The characteristics of formation water can change during the oil production period as more reservoirs are tapped or leakage occurs between reservoirs. Formation waters may contain significant concentrations of toxic materials; i.e., cyanide, cadmium, chromium, lead and mercury (EPA, 1974). Therefore, it is concluded that formation waters represent a potential significant hazard which could degrade the water quality and which may have adverse effects on the marine biota. Injection of formation waters into depleted, producing or unrelated formation could eliminate this effect on water quality. Table 71.1 indicates the content of three representative brines (formation water) from offshore Louisiana. They are classed as formation waters containing: high, average, and low solids.

Water quality could be further degraded as the result of accidental oil spills. Part of this spilled oil would be removed by clean-up operations and some would probably be dispersed into the waters of the Gulf where it will be reduced further by microbial degradation and weathering.

It is estimated (USGS, 1975) that zero-two terminal storage facilities may be constructed onshore as a result of this proposed sale. This proposed construction may have a slight impact on the water quality in the vicinity of these facilities.

Table 71.1 CHEMICAL CONTENT OF REPRESENTATIVE OFFSHORE BRINES 1/

Offshore Louisiana

| Component | | High Solids | | Average Solids | | Low Solids | |
|---|---|---|---|---|---|---|---|
| | | mg/1 2/ | % | mg/1 | % | mg/1 | % |
| Iron | FE | 153 | 0.057 | 15 | 0.011 | 139 | 0.226 |
| Calcium | Ca | 17,000 | 6.287 | 4,675 | 3.294 | 772 | 1.254 |
| Magnesium | Mg | 2,090 | 0.773 | 1,030 | 0.726 | 152 | 0.247 |
| Sodium | $Na^+$ | 84,500 | 31.250 | 49,120 | 34.612 | 22,651 | 36.800 |
| Bicarbonate | $HCO_3$ | 37 | 0.014 | 100 | 0.070 | 933 | 1.516 |
| Sulfate | $SO_4=$ | 120 | 0.044 | 0 | 0 | 188 | 0.305 |
| Chloride | $Cl^-$ | 166,500 | 61.575 | 86,975 | 61.287 | 36,717 | 59.652 |
| Total Solids | | 270,400 | 100% | 141,915 | 100% | 61,552 | 100% |

1/ From U. S. Geological Survey, Oil and Gas Supervisor, Gulf of Mexico Area. New Orleans, Louisiana.

2/ mg/1 is equivalent to part per million.

D. Impact on Ship Traffic and Navigation

In the Gulf of Mexico safety fairways have been established for the safe passage of vessels enroute to or from U. S. ports. Consequently, placement of rigs or platforms are prohibited within these fairways. (Section IV, B) Ships do not always use these fairways and this increases the possibility of a collision with drilling rigs, permanent platforms or vessels attending these platforms. Impacts which could result include loss of human life, spillage of oil, release of debris, including part of or the entire drilling rig and the ship, if it sinks. The contents of the ship's cargo could pose a serious threat to the environment if it includes toxic materials, such as chemicals, crude oil or refinery products.

A marine casualty is any casualty involving a vessel other than a public vessel, if such casualty occurs upon the navigable waters of the United States, its territories or possessions; or any casualty involving a United States vessel wherever the casualty may occur. Casualties involving commercial vessels are required to be reported to the U. S. Coast Guard whenever the casualty results in any of the following: actual physical damage to property in excess of $1,500; material damage affecting the seaworthiness or efficiency of a vessel; stranding or grounding; loss of life; or injury causing any person to remain incapacitated for a period in excess of 72 hours, except injury to harbor workers not resulting in death, and not resulting from vessel casualty or vessel equipment casualty.

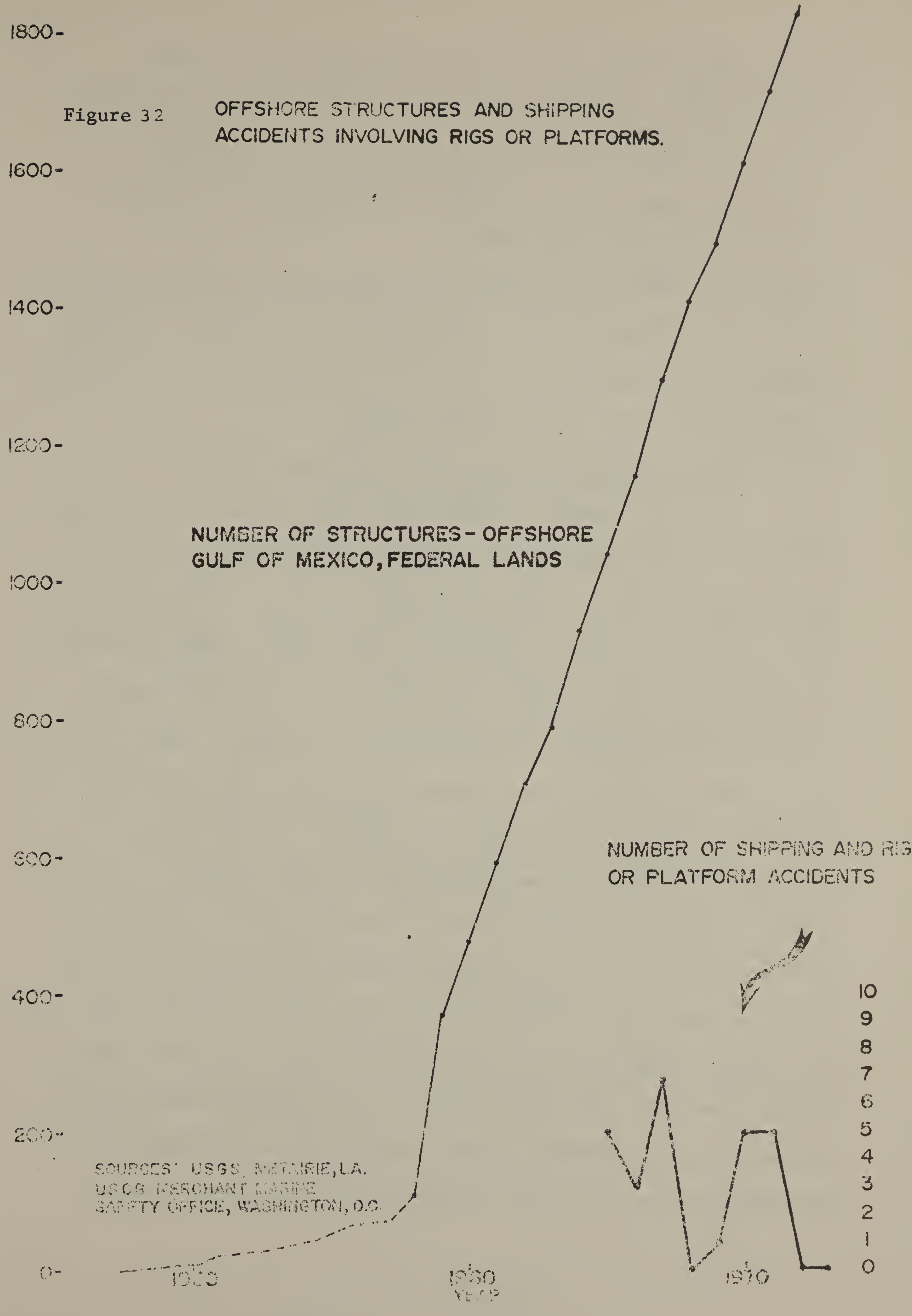
Eight cases of collision involving vessels of over 1,000 gross tons were reported in the Gulf of Mexico during the period of July 1, 1962, through June 30, 1973. Twenty-two other collisions of vessels less than 1,000 gross tons with fixed structures were reported during this eleven year period. Fifteen of the accidents involved vessels less than 100 gross tons and the remaining seven vessels were between 100 and 650 gross tons. Of the twenty-two accidents, there was no loss of life involved and damage to the rig was insignificant (USGS, 1974).

Figure 32 shows the increase in the number of offshore structures versus the small number of accidents during the period 1965 through 1973 involving these platforms in the Gulf of Mexico. It should be noted that the number of accidents involving structures is not increasing while the number of structures is increasing. The accidents involving small vessels might in some cases be considered self-generating; that is, the fishing vessels could have been near the rigs due to the improved fishing around the structures and the barges, cargo and passenger vessels could in some cases have been servicing the platforms.

The most serious environmental hazard involving offshore structures and shipping accidents would occur in the case of an oil tanker colliding with a platform. In this theoretical case, supertankers might be considered in a more favorable light than small tankers if the following were the case:

(1) The offshore terminal buoy process was used. These are known as offshore deepwater terminals or "Superports".

Figure 32 OFFSHORE STRUCTURES AND SHIPPING ACCIDENTS INVOLVING RIGS OR PLATFORMS.



(2) The fairway, the area near the fairway, and the area around the terminal buoy had no nearby bathymetric hazards, or these hazards were carefully surveyed and marked.

(3) The super-tankers were kept in the fairways in the area of offshore structures.

(4) The super-tanker traffic was restricted to one way traffic in the fairways so that tankers were never on head-on courses.

In summary, the possibility exists for an increased number of collisions to occur as the number of platforms increase.

E. Impact on Military Uses of the Continental Shelf

The Gulf of Mexico is used rather extensively by the Navy and Air Force for conducting military training and research operations. These current activities consist of missile testing, ordnance testing, drone recovery operations, electronic counter measure (ECM) activities by the Air Force and training of military personnel. Mine research activities are conducted by the Department of the Navy. Most of this activity takes place in areas designated for these purposes. Live ordnance testing by the Air Force occasionally involves emergency release of ordnance outside designated bombing areas; however, these are limited to practice bombs containing 10-pound explosive. Because Air Force procedures provide for dropping ordnance over water in the event of an emergency which precludes the use of a designated salvo area, potential hazards, however remote, exist in every tract within the defense warning area W-151 (see Figure 20.1). Such emergencies have occurred in the past, and ordnances have been jettisoned as far shoreward as Choctawhatchee Bay. No quantitication as to the amount of ordnance

located in and outside the salvo areas was available. The possibility of occurrence of unexploded munitions on the ocean floor in the proposed lease sale is extremely remote.

Oil and gas operations in an ordnance disposal area are potentially hazardous. The accidental detonation of munitions during the course of oil and gas drilling or other activities should it occur would result in loss of life, destruction of property or creation of potential for fire and polluting events and death or injury by concussion to marine life. At this time, we consider the probability of occurrence low because unexploded ordnances and sunken WW II vessels are detectable through magnetometer surveys and sophisticated magnetic detection devices. Also, in many cases, divers can be used to aid in locating and plotting munitions and sunken vessels on the ocean floor.

Use of the active salvo areas for ordnance disposal should these areas be made available for oil and gas operations would have to be discontinued.

The possible use of shallow, nearshore portions of the continental shelf for ordnance disposal would prohibit full exericse of the multiple use concept common to natural resource management programs. However, it is not DoD policy to dispose of ordnance in shallow waters. Such disposal is only carried out in an extreme emergency and only when necessary for the preservation of life or saving of an aircraft and never as a routine disposal procedure. Therefore, this conflict is not anticipated should this sale proceed.

F. Impact on Beach and Shoreline Recreation

Recreation activity on beaches and in shoreline areas can receive impacts from pipeline construction onshore, from oil spills, and from the placement of onshore facilities (such as production terminals or transfer facilities) should they be located in or near a recreation area.

No pipelines are projected to be brought ashore as a result of this sale, unless production results in an area remote from existing transportation facilities, such as in the Florida frontier area. If a pipeline crosses a beach area used for recreation, there will be an impact. The area of beach disturbed by construction would be fairly small (30 feet wide) and high tides following burial of the pipeline would soon serve to restore the beach terrain. Restoration of the beach would take longer, most likely requiring a storm tide or high winds to obliterate the effects of excavation. Should a pipeline enter a marsh shore there would be little beach activity to be affected; however, there could be long lasting visual impacts due to vegetative and drainage disturbance in the laying process. Likewise, a pipeline crossing a shore backed by forest vegetation will produce an obvious corridor which may be noticeable for many years. Physical interference with recreational activities, should a pipeline be needed, will be minimal and shortlived.

If production terminal facilities are located

in or near a beach or other area used for recreation, there will be an adverse impact from disruption during the construction phase and elimination of about 40 acres per terminal plant for recreational uses. This latter impact would be long-term and restoration of the area, if attempted at all, would have to await depletion of the off-shore production which the plant would be designed to serve. These impacts may tend to diminish quality of the area for recreational enjoyment.

Water sports, such as swimming, diving, spearfishing, underwater photography, fishing for finfish and shellfish, boating and water skiing would also be directly affected by an oil spill. These would also be affected where chronic low-level discharges have caused a degradation of the environment.

Other marine related activities, such as beachcombing, shell collecting, painting, shoreline nature study, camping and sunbathing would be made much less attractive for an indeterminate period where an oil spill had coated a beach.

Removal of oil from beaches used for recreation in the area under consideration would probably involve removal of the contaminated sand and possibly replacement of the sand, if needed. The time period for clean-up in this case would depend on the extent of beach affected. Recreational use of the area would be precluded during the time that oil covered the beach and during the clean-up process, also.

The impacts of an oil spill discussed above would be more keenly

felt if the recreation area involved is intensively used or considered to have unique or outstanding recreational values, such as many of the popular recreation areas along the eastern Gulf coast or Galveston and Padre Islands. Not only would the impact be felt by the recreational users of the area, but, consequently, the community of businesses whose economic well-being depends on use of their recreational resources by tourists, would be affected. If an oil spill were to cover outstanding recreational beaches during the heights of the recreational season, the impact could be expected to be more severe, in that residents and tourists would not be attracted to a beach area contaminated by oil or undergoing a clean-up process, and there would be a resultant economic loss.

As a result of this sale up to 100 miles of new pipeline may be needed and from zero to two new onshore terminals. Location of facilities would, of course, depend upon which tracts are leased and where new production actually occurs. It is unlikely that any new pipeline land-falls or shore facilities would be needed in the central Gulf area. In the Florida area this sale could add incrementally to the length of gathering lines and the volume of use for facilities already anticipated due to OCS Sale 32.

Fifty-one blocks, expected to produce oil and gas, lie west of the Tampa Bay area. These extend approximately 90 miles along a northeast to southwest axis. The block closest to land lies approximately 25 miles west of Indian Rocks Beach (west of Tampa), and the one farthest from shore lies about 80 miles southwest of Ana

Maria Key (mouth of Tampa Bay). Currents in this area set toward shore only a small part of the year, and annual winds show a moderate dominance of offshore flow. However, winds may blow from any point of the compass and especially during frontal passage could rapidly push an oil spill toward adjacent beaches. (See visual Graphic No. 6, Eastern Gulf of Mexico, Vol. 3).

In addition to the recreation beaches vulnerable to potential oil spills from production in this area, Pinellas County Aquatic Preserve, Anclote Key State Park, Caladesi Island State Park and Pinellas and Passage Key National Wildlife refuges could be effected.

Four isolated blocks are offered in the Apalachicola leasing area. These are oil and gas prone, and the closest shore is approximately 50 miles to the northwest along the outer beach of St. George Island. This shore is rimmed with excellent recreation beaches, aquatic preserves, state parks and a national wildlife refuge. The small potential reserves involved and the great distance from shore should render the probability of oil spill damage from these leases quite low.

Five potential oil and gas producing blocks lie approximately 35 miles west of Cape San Blas. The beaches of the Panama City area lie approximately the same distance to the northwest.

One oil and gas prone block lies approximately 18 miles from Petit Bois Island in the Gulf Islands National Sea Shore. Breton National Wildlife Refuge lies approximately 20 miles to the west. One oil tract lies approximately three miles and another seven miles from Breton National Wildlife Refuge. Both are about four miles

from the Delta National Migratory Waterfowl Preserve. An oil prone partial block lies three miles from the Pass-a-Loutre State Game and Fish Preserve at the mouth of the Mississippi and one gas and four oil and gas prone blocks lie eight to twenty miles off the Mississippi Delta. No recreation beaches exist near these tracts but oil spills could damage the national and state wildlife refuges.

Proposed leases off central and southwest Louisiana are mostly gas prone and lie more than 50 miles from shore, except for two partial oil and gas tracts 15 miles from Marsh Island and three oil and gas tracts eight to fifteen miles from shore in the Vermilion and East Cameron areas. Two gas tracts lie four to six miles off Cameron Parish and quite near Rutherford Beach. Although this stretch of shore contains Holly, Rutherford, and Hackberry beaches and Rutherford Beach State Park, the expected gas production should pose no threat of oil spills. Another gas tract lies about 22 miles south of Rutherford Beach State Park and several others still further out.

Nearly all of the blocks offered in the Texas areas are potential gas producers. The exception is composed of three oil and gas tracts adjacent to the three league line in the High Island Area southwest of Sabine Pass. Twenty blocks in the High Island South Addition areas are all 80 or more miles from shore. Four partial blocks are adjacent to the state territorial limit in the Brazos and Matagorda area. Three additional blocks are approximately 18 miles from St. Joseph and Mustang Islands.

Barrier islands along west Florida, Alabama, Mississippi, east Louisiana and the Texas coast offer considerable protection to bays and estuaries against encroachment of offshore oil spills. These barrier islands and their beaches are a major recreation resource in their own right and oil spill damage could be significant. However, where wave action is strong the effects of an oil spill should be shorter lived on the outer beaches than in the bays and estuaries.

In general, if an oil spill did reach any shore or beach area, an unquantifiable amount of recreation could be curtailed for a period of several months. The probability of this occurring is considered remote for the total area encompassed by the proposed sale.

G. Impact on Aesthetic and Scenic Values

If air quality permits unlimited visibility, some portion of a one hundred foot structure can be seen from the beach if it is located 17 miles or less from shore. To some people the sight of such offshore oil structures would be aesthetically unpleasant.

All of the lease blocks offered in the MAFLA area lie well beyond the visual range of adjacent beaches. There are seven blocks offered around the Mississippi Delta on which structures might be visible from the Pass-a-Loutre, Delta, or Breton Wildlife refuges. At present approximately 50 structures are visible from the Delta-Gulf Island NWR (Widner, 1975, personal communication).

Two partial blocks in South Marsh Island North Addition would be visible from Shell Keys National Wildlife Refuge and possibly Russel Sage Refuge on Marsh Island. Further to the west three

tracts in Vermilion and East Cameron areas may be visible from beaches at the proposed Cheniere-au-Tigre State Park and Rockefeller Wildlife Refuge. Two additional tracts lying about four miles off Rutherford beach would be easily visible from shore.

Along the Texas Coast seven offered blocks lie within visual range of the beach and two more may possibly be seen from St. Joseph or Mustang Island. In all cases they lie over ten miles from shore.

Any floating material, such as debris or oil that is cast upon the beach or washed into a bay, would constitute an impact upon the aesthetic values for users or owners of the area.

Even after burial of a pipeline, the scars will cause an impact on the aesthetic values of the beach and associated shoreline. It is our estimation that the impact will endure for at least a year, until sand has been redistributed by wind, tides and rain and another growing season brings about revegetation.

Revegetation of dunes crossed by pipelines would reduce adverse effects from an aesthetic and scenic viewpoint and would decrease the chance of destruction of the dunes by erosion. It is not, however, within the Federal Government's authority to require the revegetation of affected dunes unless they are on federal lands. State or local authorities may require revegetation of dunes disrupted by pipeline installations.

In marsh areas where it is impossible to backfill canals or

ditches because of the unconsolidated nature of the substrate, there will be an adverse impact on aesthetic values if any pipelines are constructed. The laying of a pipeline in these areas would result in an open canal or ditch through the marsh. However, this would be an add-on effect in the central Gulf since there are at present numerous canals or ditches of this type.

There will be an adverse impact on aesthetic and scenic values resulting from construction of onshore terminal and produce storage facilities and pumping stations if these facilities are located in areas valued for their natural or scenic qualities. Some people will find the visual impact of these facilities aesthetically displeasing. There also may be noise pollution associated with vehicular traffic to and from these facilities and noise pollution resulting from pumping stations that would reduce the serene and natural qualities of an aesthetically enjoyable area.

The probability is considered low for the aforementioned impacts to occur. However, if any did occur, the duration would depend on numerous variables and the extent would be reflected partly in an individuals own values.

H. Impact on Conservation Resources

The impact of oil spills and pipeline and onshore facility construction on biota, air and water quality, beaches, etc., has been discussed previously. Should an oil spill occur in a conservation area, or should pipeline and onshore facility construction occur in one of these areas, the impacts discussed above will apply.

As previously mentioned, Breton and Delta National Wildlife Refuges and Pass-a-Loutre State Refuge are very close to three oil prone tracts and Pass-a-Loutre is moderately close to four oil and gas prone tracts. With onshore winds oil spills could reach these marshes in a few hours. Block 53 in Chandeleur Sound, if leased and developed, would be the closest Federal lease to the Breton Islands portion of the Breton Refuge. It should be noted that the Mississippi Delta is surrounded by leased and developed tracts and the current offering represents a small incremental increase in oil spill risk.

The closest tract to a conservation area off Florida is Block N637 E58, Tampa Area which lies a little more than 20 miles west of the Pinellas Co. Aquatic Preserve. Pinellas National Wildlife Refuge and Cockroach Key Aquatic Preserve are somewhat protected from offshore spills by location within the Tampa Bay mouth. Due to distance from shore, expected production of gas and relatively small potential reserves offered we consider the threat of oil spills to adjacent conservation areas to be moderate to low.

In Texas only Brazoria National Wildlife Refuge extends to a beach exposed to the open Gulf. The closest tract offered is about 28 miles to the southwest and is expected to produce only gas. The threat to conservation areas along the Texas coast as a result of this proposed sale is negligible.

## I. Impact on Historical and Archaeological Sites, Structures and Objects

Impacts on these features could stem from two sources. During an oil spill, any objects coated with oil would obviously be rendered less useful and valuable and may not survive cleaning operations. In addition, porous items, such as wood, pottery, or shell, may be internally contaminated with oil and this might interfere with carbon dating procedures.

During drilling, pipeline burial operations, or construction of terminal, storage, or pumping facilities, as yet undiscovered archaeological sites or objects and shipwrecks may be damaged or destroyed.

Prior to drilling or the laying of a pipeline, where there is believed to be a potential for archaeological resources, the area affected must be surveyed using magnetometer, dual side scan sonar, sub-bottom profiler and depth sounder. These surveys are currently conducted to a depth of at least 60 meters and in deeper waters where there is reason to expect submerged cultural resources.

These requirements will be refined when a Department of the Interior study is completed of the potential for submerged cultural resources in the northern Gulf of Mexico.

J. Impact on Sport Fishing and Recreation Boating

Although we have no conclusive evidence, it is our opinion that a major oil spill would affect sport fishing and recreation boating adversely. Boaters and fishermen would not want to soil their boats by entering a contaminated area for the duration of the spill incident.

Aside from damage caused by oil spills, there is considerable evidence that oil and gas operations have a favorable impact on sport fishing activities.

The favorable impact is the result of sports fish concentration due to the artificial reef effect on offshore platforms. In the open sea, offshore platforms provide both food and cover in areas that are largely devoid of those essentials. Myriad forms of microorganisms in the water drift by these structures and attach themselves, soon encrusting all exposed surfaces on the platform. Hard substrate is necessary for encrusting organisms, such as barnacles, hydroids, corals, mussels and other invertebrate organisms which serve as links in the food chain. Randall (1968) has stated that artificial reefs provide protection, food sources, spawning sites and spatial orientation markers for fishes. The same author found that artificial reefs attract available fish from surrounding waters, and increase the size of some populations by providing additional protected areas and food for both young and adults. The typical platform located in 100 feet of water will have a surface area of about two acres (over 87,000 square feet). (Shinn, 1974). Other advantages of these

structures is the free movement of water through and around them and their high profile. The high profile provides habitat for a wide variety of fish from the turbid dark bottom zone to the lighter and clearer surface waters. Platforms are easily located by boaters and fishermen and the platforms and their personnel are a source of emergency assistance for all offshore sportsmen.

Offshore platforms are the major focus of sports divers from coastal Louisiana and may be expected to contribute significantly to the sport as their number increases in other areas of the Gulf. Divers are drawn to these structures for spear fishing, photography and general pleasure diving. The submerged portion of a structure contributes to safety by assuring the divers' orientation to depth and distance (Steve Estopinal, personal communication).

It is expected that between 20 and 50 new platforms will be added, as a result of this sale, to the more than 2000 in existence in the northern Gulf of Mexico.

## K. Other Impacts

### 1. Induced Industrialization in the Coastal Zone

#### a. Introduction

Although federal legislation influencing land use and refinery siting is presently under consideration, the federal government presently has little direct control over the spatial distribution of onshore activity induced by offshore production. This function, to the extent that it might exist, remains a state, regional or local responsibility.

The incremental and separable onshore effects attributable to this sale are difficult to identify and quantify because: (1) The proposed sale represents only a portion of a continuing activity in the coastal areas adjacent to the Gulf of Mexico. (2) The potential offshore production and onshore inducements resulting from this sale exist in synergism with interrelated, interdependent and potentially more dominant and overriding externalities, such as, the importation of foreign crude and the level of exploration and production activity onshore and in state waters. These activities might induce onshore responses similar to the onshore effects induced by activities on the outer continental shelf.

The quantities of crude oil and condensate currently produced from the various onshore and offshore areas have been included in the description of the petroleum industry in the Gulf of Mexico area.

#### b. Basic offshore production development assumptions

After consultation with the Geological Survey and

representatives from industry, an estimated timetable and development sequence was used to determine the projected daily and annual production rate, and other aspects of the sale's impact. This timetable is shown as Table 72, and incorporates the following assumptions:

(1) The number of rigs utilized would increase to the maximum of 6 during the second year following the sale, (this time lag is due to increased competition with recent offshore sales in the Gulf), maintain this rate for two years and then be reduced to zero at the end of the fifth year.

(2) After a discovery has been made, the final platform design is completed, fabrication is completed and the platforms are installed during the third to eighth year.

(3) At this time, development drilling is started and 300 wells on platforms are drilled during the next years. Platform oil, gas and water treating facilities are installed after the wells are completed. With this schedule, the first platform is installed during the third year and the last one installed during the eighth or ninth year.

(4) Production can be started approximately four years after the first discovery if pipelines are installed with the first platform. For this model, it was assumed pipelines would be used with production separated and treated onshore. Production was then modeled to begin during the fifth year and at the completion of development drilling leveling off at the maximum value in the tenth year. A summary of the anticipated development scheme with further assumptions as shown in Tables 73 and 74.

Table 72 . Lease Sale 41: Hypothetical Development Timetable; High Estimate

| Year | Exploratory Wells | Platforms | Development Wells | Pipelines (miles) | Terminals |
|---|---|---|---|---|---|
| 0 | | | | | |
| 1 | 10 | | | | |
| 2 | 30 | | | | |
| 3 | 30 | 5 | | | |
| 4 | 20 | 10 | 25 | 10 | |
| 5 | 10 | 10 | 50 | 20 | |
| 6 | | 10 | 75 | 20 | |
| 7 | | 10 | 75 | 20 | |
| 8 | | 5 | 50 | 20 | 2 |
| 9 | | | 25 | 10 | |
| 10 | | | | | |
| Totals | 100 | 50 | 300 | 100 | 2 |

Table 73 The Expenditures Estimated [1/] to Result from Lease Sale 41 Range from Approximately $342 to $836 (million)

| Expenditures | Low Estimate | High Estimate |
|---|---|---|
| 1. Well drilling | | |
| Exploratory wells | $130,000,000 | $130,000,000 |
| Development wells | | |
| Productive | 40,000,000 | 270,000,000 |
| Dry | 7,500,000 | 22,500,000 |
| Total Well Investment | $177,500,000 | $422,500,000 |
| 2. Platforms | $140,000,000 | $350,000,000 |
| 3. Pipelines | $ 25,000,000 | $ 50,000,000 |
| 4. Terminal/Storage facilities | 0 | $ 13,600,000 |
| Totals | $342,500,000 | $836,100,000 |

[1/] Above table based on the following estimated costs.

| | |
|---|---|
| Exploratory well | $1,300,000 |
| Development well | |
| Productive | 1,000,000 |
| Dry | 750,000 |
| Platform | 7,000,000 |
| Terminal/Storage facility | 6,800,000 |
| Pipeline (per mile) | 500,000 |

Table 74. Lease Sale 41: Annual Summary of Investment; High Estimate (in millions of dollars)

| Year | Exploratory Wells | Platforms | Development Wells | Pipe-lines | Terminals | Totals |
|---|---|---|---|---|---|---|
| 0 | | | | | | |
| 1 | 13.0 | | | | | 13.0 |
| 2 | 39.0 | | | | | 39.0 |
| 3 | 39.0 | 35.0 | | | | 74.0 |
| 4 | 26.0 | 70.0 | 23.8 | 5.0 | | 124.8 |
| 5 | 13.0 | 70.0 | 48.8 | 10.0 | | 141.8 |
| 6 | | 70.0 | 73.8 | 10.0 | | 153.8 |
| 7 | | 70.0 | 73.7 | 10.0 | | 153.7 |
| 8 | | 35.0 | 48.7 | 10.0 | 13.6 | 107.3 |
| 9 | | | 23.7 | 5.0 | | 28.7 |
| 10 | | | | | | |
| Totals | 130.0 | 350.0 | 292.5 | 50.0 | 13.6 | 836.1 |

### c. <u>Hypothetical onshore development scheme and general land use requirements</u>

Portions of the Louisiana and Texas coast have developed a nearly self-contained gas and oil related infrastructure in the form of service, support, production, transportation, storage, processing, etc. facilities. The activities and facilities required by this sale will therefore fall within the broad framework of like activities and facilities in these and other sales adjacent to the Gulf of Mexico.

The extent of the existing facilities in the Gulf of Mexico area have been described in Section II. I. 4.

It is assumed that the location of sale-induced support facilities is only loosely correlated with the specific offshore points of origin, and that they will, tend to locate in areas presently committed to and experiencing like facilities and inducements. In general, the types and extent of existing land development are strong determinants in setting the pattern for future land development.

In particular, existing land development and activities related to the oil and gas industries are expected to be strong locational factors influencing sale related land use inducements. Areas presently committed to a highly developed gas and oil related infrastructure are expected to have a greater tendency towards, and land use precommitment to, expansion of these activities than will those areas with a low or non-existent level of development. Should new incremental requirements be induced by the sale, they will be essentially an

expansion of the present capabilities. Exceptions to this general statement are noted in later portions of this section.

Sale inducements are not generally expected to overload this existing or historic capacity. Should the sale cause incremental increases in any segment of the infrastructure, such increases are assumed to occur in presently industrialized areas, probably through more intense use of lands already dedicated to such uses.

Using the preceding estimates and general assumptions, the following development scheme and general land use requirements have been addressed: Barging from production areas to shore; Gas and oil pipeline development; Oil transhipment; Refinery construction; Onshore support facilities. Each of these activities has not been developed in detail because of widely varying economic conditions, the unknown production characteristics of the wildcat acreage and the wide range of development alternatives available to the producers. However, the following is one realistic onshore development alternative, and the following estimates and land use assumptions have been developed for each major activity. These remain constant for any amount of production within broad daily ranges.

(1) <u>Barging from production areas to shore</u>

Because of the anticipated production characteristics, and weather constraints, no barging from production sites to onshore receiving facilities is anticipated. It has been assumed that pipelines would be installed early in the development program, and would be functional at the time of production, eliminating the

need for this barging requirement.

(2) <u>Gas and oil pipeline development</u>

If the production anticipated to result from this sale should be from the tracts located offshore from the Louisiana coast and the upper coastal area of Texas, the existing onshore and offshore pipeline infrastructure appears to be sufficient to accomodate the estimated quantities of oil and gas production. It would be necessary to install some offshore pipelines to link the new wells and production facilities to the existing offshore pipeline network.

In the event productive tracts were located off the coast of Florida, the construction of additional offshore and onshore facilities may be required. The following comments concerning additional gas pipeline construction in the state of Florida were obtained from an attachment to a letter from the Chairman of the Federal Power Commission, addressed to the Bureau of Land Management and dated January 3, 1975. The attachment was entitled Federal Power Commission Staff Comments on Possible Sale of Oil and Gas Leases Offshore Florida.

In order to utilize any new gas supplies discovered in the area of the possible sale, new offshore pipeline construction will be required. As to additional onshore pipeline facilities, this will depend upon which pipelines transport the gas and whether their systems are being utilized. However, it is unlikely that extensive additional onshore facilities would be required unless the development

of the Florida area greatly exceeds expectations. To the extent that one of the interstate pipelines supplied from this area is currently curtailing deliveries, there should be spare onshore pipeline capacity to deliver part, if not all, of the new supplies resulting from the development to be included in the proposed sale.

If profitable quantities of oil are found in any of the tracts, it is assumed that oil pipelines will be developed offshore to connect new fields with new onshore terminals. No new overland pipelines are anticipated.

(3) Oil transhipment

It is assumed that all oil production will be pipelined to shore, stored in oil tank farms and finally transferred to existing refineries, by means of existing pipelines or tanker and barge facilities.

(4) Possible refinery construction

As discussed below, production from offshore areas will tend to offset declining onshore reserves. The total refinery and petrochemical capacities in the Texas and Louisiana coast has been and will continue to be in response to the region's need to supply crude oil and products to adjacent regions and to meet its own needs, and this total will be derived independently of this lease-sale's possible contribution. Since this current capacity processes and will probably continue to process a combination of locally produced (onshore and offshore) and imported (domestic and foreign) crude oil; that produced by this sale is perceived to be

inclusive of this total rather than constituting an additive factor.

The principal effect of this sale on the industrial environment of the coastal areas of the Gulf of Mexico is believed to be the resulting tendency to preserve the existing industrial and economic activity in the region.

This conclusion is based on several factors, including:

(a) The extensive industrial development in the area. These industries have developed over a period of many years, and have been based on existing reserves of oil and gas in the area.

(b) The current decline in crude oil and condensate production in the coastal area of the Gulf of Mexico.

(c) The importation of crude petroleum for refining in facilities located in the coastal zone.

The extensive existing refining capacity and petrochemical production facilities have been described in the section of this statement concerning with the existing industrial climate in the area.

The extent to which crude oil and condensate produced from tracts leased as a result of this sale will displace imported crude oil and condensate will probably be dependent, in large part, on the relative prices of domestic crude oil and imported crude oil.

The following comparisons are based on tables published in the February, 1975 issue of Monthly Energy Review, a publication of the Federal Energy Administration.

Approximately 66 percent of the domestic crude oil production was valued at the wellhead at $5.25 per barrel. This oil is referred

to as old oil and is subject to price control. The remaining 34 percent of the total domestic crude oil production is referred to as uncontrolled oil and is sold at the free market price. Uncontrolled oil consists of new oil, released oil and oil produced from stripper wells. The price of new oil during November, 1974 was estimated to be $10.83 per barrel.

A preliminary estimate of the average cost for all domestic crude petroleum delivered to refiners during November was $7.46 per barrel, which was substantially higher than the revised October figure of $7.26 per barrel. The refiner cost of imported crude petroleum was estimated to be $12.53 per barrel during November, 1974, or approximately $5.07 more than the refiner's average cost of domestic crude. A comparison of refiner acquisition cost of new oil with the landed cost of imported crude is difficult, due to the necessity of adding transportation costs to the wellhead price of new oil in order to arrive at a comparable cost to the refiner, but it appears probable that at least at the present time, new domestic crude petroleum is less costly than imported crude petroleum.

It is assumed that the additional production from tracts leased as a result of this sale will displace imported crude petroleum, as well as replace the presently declining domestic crude oil production. This effect would not be anticipated to initiate an increase in refining capacity, but rather to continue the operation of the existing refineries located in the Gulf of Mexico region.

(5) <u>Support facilities, operating bases, etc.</u>

By "support facilities" is meant a wide variety of supply and service industries having capabilities to support the exploration, production and transportation of gas and oil. It includes companies dealing with tools, wireline, gas lift, cement, boats, etc., as well as machine and welding shops, trucking firms, wellhead and mud suppliers, supply stores, etc. Such capability is present in many industrialized areas within the Louisiana and Texas coastal areas, and it has been assumed that excess capabilities exist in virtually all sectors which will be stimulated and utilized by sale related demands. It is not anticipated that the sale will create new demand for lands dedicated to these uses.

The individual and total sale induced acreage is assumed to be very small, and these requirements may be widely dispersed over large portions of the coastal zone. It can be assumed that the region has many site alternatives to those indicated which could host the modest acreage requirements, should development of the sale be different from that assumed.

Industrial development was used as the basis for land use requirements, as its site demands are most relevent to sale related activities. However, in doing so, it is understood that this land use represents only one component of a balanced land use - population ratio. Industrial development induces new employees and activities into the general sale area, and these will be distributed to more specific areas. This suggests land use implications beyond these specifically addressed

because of requirements for residential, commercial, recreation and other land use categories.

Any population or industrial inducement can be perceived as creating environmental stress for a localized area or general region. Conversely, shifting of developmental pressure to such areas can be perceived as relieving stress in other areas. Whether the result is a net gain or loss of environmental stress, is partially dependent on the relative stresses experienced in the areas which gain or lose population, and, the capability of the receiving area to accomodate new development. It is axiomatic that stress induced into an area can often be mitigated by rationally developed, goal oriented, policies and land use plans. Subsequent allocation of land in response to these demands remains a responsibility of state, regional and local governments. Because of the time lag between the lease sale and the resulting land use impacts, there is sufficient lead time for these entities to develop responsive land use plans and policies.

## 2. Economic Effects

Although the acreage offered by this sale extends from the coast of Texas to the outer continental shelf west of Tampa, Florida, the principal economic effects of the oil and gas produced as a result of this sale are anticipated to be experienced in the states of Louisiana and Texas. After leasing, exploration and development activities have been completed, the exact geographic location in which economic activity will be most likely to result can be more precisely identified.

Oil and gas produced as a result of this sale will become available at some time in the future, and the impact due to the economic activity resulting from this sale will take place in the economic climate that exists at this time.

Currently, an increased number of rotary drilling rigs are in operation, and the total wells drilled during 1974 are higher than the number of wells drilled during 1972 and 1973. The limited availability of additional drilling capacity and steel supplies may delay the development of the leases awarded as a result of this sale, thereby causing a reduced annual economic effect that would otherwise be anticipated.

Although the quantities of oil and gas that may be produced from leases awarded as a result of Sale 41 are estimated to be incremental additions to the existing production of oil and gas on the Gulf of Mexico OCS, these sale related additions of between 35,000 to 120,000 barrels of oil per day and 0.5 - 1.1 billion cubic feet of gas per

day, would be significant.

During the month of December, 1974 crude petroleum production from the Louisiana offshore area amounted to 845,600 barrels per day, and crude petroleum production from offshore Texas amounted to 2,500 barrels per day. (Bureau of Mines, December, 1974.)

The impact on the economy of the coastal areas adjacent to the sale would be dependent on the location of the production. If this estimated quantity of production should be discovered in the central Gulf of Mexico region, or in that portion of the Outer Continental Shelf located adjacent to the Texas Gulf coast between Corpus Christi and the boundary with Louisiana, it is probable that there would be little inducement to an expansion of the economy in these areas. Platforms would have to be constructed, wells would have to be drilled and pipelines linking the additional production facilities to existing transportation systems would be required.

This activity can be considered to be an extension or continuation of present employment and industrial patterns related to the existing petroleum based economy within the region.

In the event that this volume of production would be obtained from the leases offered adjacent to the coast of Florida, additional facilities for the support of drilling and production operations, as well as facilities for the transportation of oil and gas produced from these leases,would probably be required.

One factor that must be considered when estimating the impact on the local economy that may result from this sale is the exploratory

activity carried forward on the tracts leased as a result of OCS Sale No. 32, an Oil and Gas General Lease Sale Offshore Mississippi, Alabama and Florida.

In the event that oil and gas production should result from the exploration activities carried on as a result of Sale 32, the facilities required to produce and transport oil and gas produced from leases awarded as a result of Sale 41 would probably be incorporated into facilities required by the earlier discoveries to the maximum extent possible. To this extent, developing estimated economic stimuli from the two sales separately may result in some degree of exaggeration.

In the event that crude oil production should be established off the coast of Florida, it is probable that the oil would be transported via pipeline to a receiving point on shore and be shipped in tankers to existing refineries. This possible transportation system would involve the use of tanker terminals.

The hypothetical development scheme considered in the Final Environmental Statement, FES 73-60, for OCS Sale No. 32 offshore Mississippi, Alabama and Florida, noted the existing tanker and barge terminals in the Pascagoula-Mobile region, Port St. Joe and Tampa, and the possibility of the need for a new or enlarged existing terminal at Tampa. The requirements for this sale would appear to be similar, but since the estimated daily crude oil production amounts to 120,000 barrels per day, compared to an estimated 443,000 barrels of oil per day that may be developed from the activity resulting from

Sale 32, fewer facilities may be required.

However some additional employment may be expected to result from exploration, production and initial processing of crude oil and natural gas that might result from this sale, and an estimate of this employment has been based on data published by the Bureau of the Census.

This employment may be an addition to the work force present in the states adjacent to the Gulf of Mexico, providing that a high level of drilling and production activity is maintained in other areas of the United States. In the event that surplus skilled labor is available within the required specialties, the impact of this sale on employment in exploration and production related activities is seen to be a tendency to preserve the existing employment.

The additional employment impact, if it materializes, is anticipated to be experienced in the fields of oil and gas exploration, production and natural gas liquids treatment.

As a means of reporting employment and wage and salary payments, the Bureau of Census publishes a series of reports entitled County Business Patterns, incorporating statistics by type of industry organized into groups.

Among the data prepared and published by the Bureau of the Census are tables presenting the last occupation of the experienced unemployed. These data are significant in providing some insight as to the numbers of persons present in an area that may become employed as a direct or indirect result of petroleum related activity

on the outer continental shelf. Additional stress on a region may be mitigated to the extent that persons within the area are employed, rather than additional persons migrating to the area as a result of OCS operations.

Table 74.1 summarizes the Bureau of Census data on a statewide basis for 1970. The figures shown apply to male and female workers aged 16 years of age and older, and also include persons who last worked more than 10 years prior to the 1970 census.

Group No. 131 includes establishments primarily engaged in operating oil and gas field properties. Group No. 132 includes establishments primarily engaged in producing liquid hydrocarbons from oil and gas field gases. Group No. 138 includes establishments primarily engaged in drilling wells for oil or gas field operations for others on a contract, fee, or similar basis, and establishments providing exploration services for oil and gas on a contract fee or similar basis.

According to statistical data published by the Bureau of the Census in the applicable volumes of County Business Patterns, during March, 1972 the number of persons employed by organizations providing oil and gas field services (SIC 138) in the five states bordering the Gulf of Mexico.

Table 75 indicates that approximately 48 percent of the reporting units and approximately 62 percent of the employees of firms engaged in the provision of oil and gas field services were located in the states adjacent to the Gulf of Mexico.

Table 74.1 Last Occupation of Experienced Unemployed

Alabama

| Occupation | Male | Female | Total |
|---|---|---|---|
| Professional, managerial and technical | 1,883 | 1,600 | 1/ |
| Sales workers | 898 | 1,476 | |
| Clerical and kindred | 1,309 | 5,127 | |
| Craftsmen, foremen and kindred | 6,431 | ND | |
| Operatives, including transport | 7,350 | 6,867 | |
| Laborers, except farm | 4,959 | ND | |
| Farm workers | 925 | 316 | |
| Service workers, including private household | 2,055 | ND | |
| Other blue collar | ND | 766 | |
| Service workers except private household | ND | 4,079 | |
| Private household workers | ND | 2,663 | |
| Total | 26,012 | 23,814 | 49,826 |

Florida

| Occupation | Male | Female | Total |
|---|---|---|---|
| Professional, managerial and technical | 7,046 | 3,630 | |
| Sales workers | 2,917 | 3.075 | |
| Clerical and kindred | 2,750 | 10,692 | |
| Craftsmen, foremen and kindred | 10,665 | ND | |
| Operatives, including transport | 7,430 | 9,183 | |
| Laborers, except farm | 6,197 | ND | |
| Farm workers | 2,732 | 1,903 | |
| Service workers, including private household | 4,986 | ND | |
| Other blue collar | ND | 1,279 | |
| Service workers, except private household | ND | 8,484 | |
| Private household workers | ND | 2,397 | |
| Total | 45,308 | 42,719 | 88,027 |

(continued)

1/ Totals for each occupation were not listed because a rounding error would result.

Table 74.1 continued

Louisiana

| Occupation | Male | Female | Total |
|---|---|---|---|
| Professional,managerial and technical | 2,580 | 1,820 | |
| Sales workers | 1,043 | 1,891 | |
| Clerical and kindred | 1,642 | 5,520 | |
| Craftsmen, foremen and kindred | 9,420 | ND | |
| Operatives, including transport | 9,533 | 3,216 | |
| Laborers, except farm | 6,884 | ND | |
| Farm workers | 1,558 | 380 | |
| Service workers, including private household | 3,007 | ND | |
| Other blue collar | ND | 969 | |
| Service workers, except private household | ND | 5,126 | |
| Private household workers | ND | 3,183 | |
| Total | 35,925 | 23,164 | 59,089 |

Mississippi

| Occupation | Male | Female | Total |
|---|---|---|---|
| Professional, managerial and technical | 1,074 | 1,104 | |
| Sales workers | 414 | 700 | |
| Clerical and kindred workers | 652 | 2,231 | |
| Craftsmen, foremen and kindred | 4,002 | ND | |
| Operatives, including transport | 4,535 | 5,075 | |
| Laborers, except farm | 3,301 | ND | |
| Farm workers | 2,411 | 1,032 | |
| Service workers, including private household | 948 | ND | |
| Other blue collar | ND | 680 | |
| Service workers, except private household | ND | 2,616 | |
| Private household workers | ND | 2,451 | |
| Total | 17,513 | 16,505 | 34,018 |

Texas

| Occupation | Male | Female | Total |
|---|---|---|---|
| Professional, managerial and technical | 6,823 | 5,343 | |
| Sales workers | 3,671 | 6,141 | |
| Clerical and kindred workers | 4,239 | 18,342 | |
| Craftsmen, foremen and kindred | 17,445 | ND | |
| Operatives, including transport | 18,790 | 11,233 | |
| Laborers, except farm | 12,956 | ND | |
| Farm workers | 4,388 | 1,317 | |
| Service workers, including private household | 7,772 | 14,348 | |
| Other blue collar | ND | 2,585 | |
| Service workers, except private household | ND | ND | |
| Private household workers | ND | 4,549 | |
| Total | 76,649 | 66,524 | 143,173 |

Table 75 SIC 138: Oil and Gas Field Services: 1972

| State | Number of Reporting Units | Number of Employees |
|---|---|---|
| Alabama | 23 | 375 |
| Florida | 28 | 1,223 |
| Louisiana | 668 | 24,165 |
| Mississippi | 157 | 3,749 |
| Texas | 2041 | 43,239 |
| Totals | 2917 | 72,751 |
| Total U.S. | 6055 | 115,706 |

During the year 1972, the number of successful and unsuccessful oil and gas wells drilled in the five state area were published by the Bureau of Mines in the Minerals Yearbook:

Number of Wells Drilled: 1972

| State | Oil | Gas | Dry | Total |
|---|---|---|---|---|
| Alabama | 13 | 9 | 93 | 115 |
| Florida | 65 | 0 | 44 | 109 |
| Louisiana | 919 | 818 | 1328 | 3065 |
| Mississippi | 87 | 13 | 317 | 417 |
| Texas | 3963 | 943 | 2760 | 7666 |
| Totals | 5047 | 1783 | 4542 | 11,372 |
| Total U.S. | 11,306 | 4928 | 11,057 | 27,291 |

The numbers of persons enumerated as employees of establishments primarily engaged in drilling wells for oil and gas are included within Drilling Oil and Gas Wells SIC 1381, a subgroup of SIC 138.

The use of census data in developing estimates concerning operations on the OCS is subject to some reservations. The number of employees recorded in one state may be engaged in exploration activity in other areas. Employees engaged in drilling activities on the OCS may work longer work weeks, and additional personnel may be employed for purposes of training in marine drilling and production operations.

However, by developing average figures based on operations for the five state area, it is anticipated that a usable, if approximate, estimate may be obtained of the employment effects that could result from this sale.

Probably additional exploration activity as well as drilling activity will result from this sale, so further estimates will be based on employment recorded within SIC 138, rather than on the employment recorded within SIC 1381.

If no additional exploration work were undertaken, the employment effects would be lower.

A comparison of the number of wells drilled with the number of persons employed within SIC 138 organizations indicated an average of 6.4 employees per well drilled during 1972 in the five state area.

| State | Number of Employees SIC 138 | Number of Wells Drilled | Ratio Employees/Wells |
|---|---|---|---|
| Alabama | 375 | 115 | 3.3 |
| Florida | 1,223 | 109 | 11.2 |
| Louisiana | 24,165 | 3,065 | 7.8 |
| Mississippi | 3,749 | 417 | 9.0 |
| Texas | 43,239 | 7,666 | 5.6 |
| Totals | 72,751 | 11,372 | 6.4 |
| Total U. S. | 115,706 | 27,291 | 4.2 |

The data published in the County Business Patterns series are based on a sample of employment taken during mid-March and may not represent an exact annual employment figure. If the assumption is made that the employee/well ratio is representative of an estimate of employment that may be expected to result from Sale 41, then approximately 6.4 employees per well will be required to develop the acreage leased as a result of this sale.

Similar data for the coastal area of Louisiana was published in An Economic Base Study of Coastal Louisiana by Jones and Rice (LSU-SG-72-02)

for the years 1967, 1968 and 1969. These data are comparable to the estimate based on the five state area for the year 1972 (Table 77).

Table 77 Number of Employees (SIC 138)

| | 1967 | 1968 | 1969 |
|---|---|---|---|
| Louisiana Coastal Parishes | 12,597 | 15,925 | 15,475 |
| Number of Completed Wells | | | |
| Onshore South La. | 1,591 | 1,634 | 1,542 |
| Offshore | 1,385 | 1,335 | 1,158 |
| Total Wells | 2,976 | 2,969 | 2,700 |
| Employees/Well | 4.2 | 5.4 | 5.7 |

At the probable peak of well drilling activity anticipated during the sixth or seventh year following the sale, approximately 75 wells would be drilled. On the basis of 6.4 employees per well, 480 employees would be required. On the basis of 5.7 employees per well, approximately 430 employees would be required. For the purpose of estimating the impact of this sale, the figure of 430 employees is preferable, as a portion of the contract geological and geophysical work would have been accomplished prior to the sale, and any employment effects would be present prior to the sale date.

Establishments primarily engaged in operating oil and gas field properties, including such activities as exploration and other operations in the preparation of oil and gas up to the point of shipment from the producing property, are included in SIC 131 Crude Petroleum and Natural Gas:

Total Employment Crude Petroleum and Natural Gas

SIC 131

| State | Number of Reporting Units | Number of Employees |
|---|---|---|
| Alabama | 16 | 176 |
| Florida | 16 | D 1/ |
| Louisiana | 438 | 14,916 |
| Mississippi | 100 | 950 |
| Texas | 2,267 | 28,042 |
| Total | 2,837 | 44,084 |
| Total U. S. | 6.774 | 84,919 |

1/ Deleted

The production of crude petroleum during the year 1972 for the Gulf of Mexico states:

| State | Crude Petroleum Production (1972) (Thousand barrels) |
|---|---|
| Alabama | 9,934 |
| Florida | 16,897 |
| Louisiana | 891,827 |
| Mississippi | 61,100 |
| Texas | 1,301,685 |
| Total | 2,264,546 |

The ratio between the number of employees within SIC 131 and the annual production rate was calculated to be one additional employee for each 51,368 barrels of annual production. The production anticipated to result from this sale ranges from 35 to 120 thousands of barrels per day, and converting these daily rates to annual rates

indicates an annual production of 12.8 to 43.8 million barrels per year. The maximum production rate would suggest the employment of approximately 1,000 persons during the period of stabilized production.

Those persons employed in establishments primarily engaged in producing liquid hydrocarbons from oil and gas field gases are enumerated in the applicable County Business Patterns under the category of SIC 132. Specific data on the number of establishments and the number of employees were published only for the states of Louisiana and Texas, although processing plants were noted as being present in the other coastal states.

Total Employment SIC 132

| State | Number of Reporting Units | Number of Employees |
|---|---|---|
| Louisiana | 51 | 973 |
| Texas | 111 | 4,219 |
| Totals | 162 | 5,192 |
| Total U. S. | 255 | 7,320 |

The total natural gas processed in natural gas processing plants in the state of Louisiana and Texas during the year 1972 were published in the Minerals Yearbook (U.S. Dept. of the Interior, 1972):

| State | Natural Gas Processed (Billion cubic feet) |
|---|---|
| Louisiana | 6,337.3 |
| Texas | 8,139.4 |
| Total | 14,476.7 |

The ratio of employees to billion cubic feet of natural gas processed per year, based on the total natural gas processed in the states of Texas and Louisiana, is 2.78 employees per billion cubic feet processed.

The natural gas production estimated to result from this sale ranges from 0.5 to 1.1 billion cubic feet of gas per day, or approximately 182 to 402 billion cubic feet per year.

The maximum rate is approximately two percent of the volume processed at Texas and Louisiana plants during 1972, and assuming that the ratio of gas processed to employees remains the same, approximately 104 persons would be employed in natural gas processing plants as a result of this sale.

The total direct employment that is estimated to result from exploration, production and natural gas processing as a result of lease sale 41 amounts to approximately 1500 persons:

| Category | Annual Employment |
|---|---|
| Oil and Gas Field Services (SIC 138) | 430 |
| Oil and Gas Extraction (SIC 131) | 1,000 |
| Natural Gas Liquids (SIC 132) | 104 |
| Total Employment | 1,534 |

The average taxable wages paid within these classifications was calculated from the payroll data provided in the County Business Patterns, and are expressed in 1972 dollars paid during the first quarter of that year:

| Category | Total Employment | Average Taxable Wage | Annual Wage Payment |
|---|---|---|---|
| SIC 138 | 430 | $8,313 | $3,574,590 |
| SIC 131 | 1,000 | $10,915 | $10,915,000 |
| SIC 132 | 104 | $11,299 | $1,175,096 |
| Totals | 1,534 | | $15,664,686 |

The persons directly employed in operations relative to the exploration and production of oil and gas can be expected to spend their wage and salary income for purchases of goods and services they require.

The provision of these goods and services will require the employment of other persons. The number of persons employed in these support industries would be dependent on the consumption patterns of those directly employed, as well as the extent to which labor within an economic system was engaged in the production of goods for consumption within the same system. Since a wage or salary worker would be expected to meet the largest portion of his needs within the area of his residence, the expenditure of wage and salary payments for items produced outside of the local economy would be expected to generate additional support employment in the area in which the item was produced.

The value of the wage and salary payments to the persons employed in support activities has been determined by calculating an average wage and salary payment for the five state area from data included within the applicable County Business Patterns publications;

| State | Total Taxable payrolls Mid March 1972 (Thousands) | Number of Employees Mid March 1972 | Taxable payroll; per employee Per Quarter | Annual |
|---|---|---|---|---|
| Alabama | $ 1,281,740 | 822,599 | $1,558,15 | $6,232.60 |
| Florida | 3,234,590 | 1,995,110 | 1,621.25 | 6,485.00 |
| Louisiana | 1,419,694 | 852,793 | 1,664.75 | 6,659.00 |
| Mississippi | 661,243 | 484,296 | 1,365.36 | 5,461.44 |
| Texas | 5,195,118 | 3,125,175 | 1,662.34 | 6,649.36 |
| Totals | $11,792,385 | 7,279,973 | | |
| Five State Average | | | $1,619.83 | $6,479.32 |
| United States | $108,084,852 | 58,015,904 | $1,863.02 | $7,452.08 |

The number of persons employed in support industries, or the employment induced in other sectors of the economy by increases of employment in basic industries has been treated in Offshore Revenue Sharing, a publication prepared by the Gulf South Research Institute of Baton Rouge, Louisiana and the Structure of the Texas Economy, prepared by Herbert W. Grubb of the Office of Information Services in March, 1973. A paper prepared by Dr. Grubb in 1972, entitled Economic Aspects of the Petroleum Industries of the Texas Economy contained some data for determining the induced employment resulting from oil related activities.

"The economic impact of a million dollar change in output of petroleum refining is shown to be $2.56 million. This represents the direct value of output from these industries plus the indirect effects from other related industries, as well as the induced effects of the changes in income of the wage and salary earners (households) invol-

ved. Each million dollar in output of crude is estimated to employ 50 workers within the economy, of which 11 are employed directly in oil field work and 39 are employed in the support and induced industries." (Grubb, 1972).

This estimate indicates that 3.5 persons are employed in support and induced industries for each person directly employed in oil field work.

In Offshore Revenue Sharing, the primary employment estimated to result from OCS activity amounted to 40,300 persons engaged in activities within the categories of mining, manufacturing, construction, chemicals and allied products and refining. The supporting employment was estimated to amount to 84,100 persons, indicating a relationship of approximately 2.08 persons employed in support industries for each person employed in the petroleum related industries.

For the purpose of estimating the impact that may be anticipated from this sale, the employment in support industries will be based on an estimate of 2.1 persons employed for each person employed in the basic oil related sectors.

Since the direct employment is estimated to amount to 1,534 persons during the years of peak activity, the induced employment during these years can be estimated to amount to an additional 3,221 persons. At an average annual wage or salary of approximately $6,480 1972 dollars the total wage and salary payments are estimated to amount to approximately $21 million in 1972 dollars.

Additional employment can be anticipated to result from the construction of pipelines, production platforms and other facilities that will be required. It is anticipated that the economic stimulus that may result from these activities will be experienced primarily in the states of Louisiana and Texas.

Standard Industrial Classification 3533, Oil Field Machinery and Equipment, includes establishments primarily engaged in manufacturing machinery and equipment for use in oil and gas fields or for drilling water wells. (Table 78). This classification includes the manufacture of rock bits, derricks and rigs, drilling tools, oil and gas machinery and equipment.

Table 78 SIC 3533 (Oil Field Machinery & Equipment)

| State | Total Reporting Units | Number of Employees |
|---|---|---|
| Alabama | (no data) | (no data) |
| Florida | 4 | 126 |
| Louisiana | 23 | 1,607 |
| Mississippi | 1 | (no data) |
| Texas | 163 | 20,303 |
| Totals | 191 | 22,036 |
| United States | 343 | 35,915 |

Source: County Business Patterns (1972), Bureau of the Census

The relative importance of this industry in the Gulf of Mexico area is evident in Table 78 and the significance of the Texas sector as a part of the entire area can be readily visualized.

The construction and installation of fixed production platforms

required by this sale will probably be accomplished in existing Gulf of Mexico facilities.

The National Petroleum Council, in response to a request from the Department of the Interior, undertook a study to determine the availability of materials, manpower and equipment necessary for exploration and production of oil during the next two years. The results of this study are contained in Availability of Materials, Manpower and Equipment for the Exploration, Drilling and Production of Oil 1974-1976, published by the National Petroleum Council, September, 1974. With reference to the construction of platforms this study concluded that the total platform requirements would be 50 platforms (150,000 tons) during 1974, 55 platforms (176,000 tons) during 1975 and 60 platforms (204,000 tons) during 1976. Contractors indicated that present yard facilities are capable of producing approximately 200,000 tons, with steel availability cited as the primary limitation to production. Present expansion plans will increase yard capabilities over the next two years, so that physical plant should not be a constraint on production through 1976.

The crude hydrocarbons produced as a result of this sale will probably receive further processing within facilities in existence in the Gulf of Mexico area. Such facilities as refineries, existing crude oil and natural gas gathering and transportation systems and petrochemical plants will be utilized to the maximum extent possible and it is anticipated that additional facilities of this type will not result from this sale.

To summarize, it appears probable that oil and gas produced as a result of this sale will provide for the continuation of existing patterns of employment in those areas adjacent to the Gulf of Mexico where the industrial infrastructure related to the oil and gas industry is established. Such activities as the construction of drilling equipment and the necessary foundation and production facilities will probably be accomplished in existing manufacturing facilities.

The impact of this sale is seen to be a possible increase in the employment of persons directly engaged in the activities related to drilling and production, and in numbers of additional persons employed in providing for the needs of those directly employed.

The total annual employment that may be expected from this sale amounts to approximately 4,750 persons. 1534 directly employed and 3,221 persons indirectly receiving employment as a result of the expenditures of the first group.

The Bureau of Census data for the numbers of experienced unemployed persons indicates that during the year 1970, the following approximate numbers of experienced persons were unemployed in the states bordering the Gulf of Mexico.

| | |
|---|---|
| Alabama | 49,826 |
| Florida | 88,027 |
| Louisiana | 59,089 |
| Mississippi | 34,018 |
| Texas | 143,173 |

To the extent that these persons are presently located in areas

situated adjacent to the localities in which oil and/or gas production may be developed, it is reasonable to assume that additional land use or demand for services would be minimal. The Census data classification and enumeration of these persons covers a wide range of occupations; including professionals, managers, technicians, sales, clerical, craftsmen, foremen, operators, laborers, and various classifications of service workers.

L. Proximity Evaluation

1. Purpose

The purpose is to analyze some of the possible impacts of the proposed OCS lease sale on the environment using a matrix analytical technique in an attempt to provide the decision-maker and reviewer with an array of factors which must be considered in order to form value judgements concerning the importance of these impacts to the environment.

In this section, each tract is included in a table designed to describe its distance from shore and its distance from significant resource factors as outlined below. In addition, the proximity to these resource factors of oil spills, if one should occur from a tract and of structures, should the tract be developed, is evaluated by means of a proximity scale. Each tract is assigned a proximity scale and number for both oil spills and structures.

2. Significant Resource Factors

The matrix analysis examines major factors which could sustain negative impacts as a result of the development of the tracts included in the proposed lease sale. Significant resource factors appear on the horizontal axis of each matrix and for purposes of this analysis have been identified and placed into two groups as follows:

a. Natural and cultural resources

(1) Refuge/Wildlife Management Areas

(2) Beach and Shoreline

(3) Intertidal Communities

(4) Reef Communities

(5) Aesthetics

(6) Archaeology

b. Multiple-use activities

(1) Shipping

(2) Outdoor Recreation

(3) Commercial Fishing

(4) Sport Fishing

(5) Military Uses

All evaluations of the above categories were based on measurement of the closest part of the tract as it related to the resource being effected.

3. Impact Producing Factors

This evaluation considers the proximity of the occurrence of oil spills and structures to significant resources and activities within the proposed sale area as being the primary impact producing factors. "Oil spills" in this context refer to a spill of 1000 barrels or more, and "structures" include platforms, fixed structures, and artificial islands.

Other impact-producing factors, such as debris and pipeline construction, cannot be analyzed on a tract-by-tract basis, and therefore, are not included in this matrix section. However these and other

factors were discussed on the basis of the entire sale earlier in the statement.

4. Proximity Values

Each tract has been assigned proximity values for oil spills and structures based on the distance the tract is from a particular resource.

A series of scales have been devised for the purpose of assigning a range of values consisting of importance and proximity to each impact-producing factor. These scales together with definitions and discussions are presented below.

a. Structures

Under some conditions, offshore structures have an adverse effect on commercial fishing activities. Depending on currents and underwater obstacles, an offshore structure can remove areas of trawling and purse seining waters. Heavy concentrations of platforms can make trawling and purse seining difficult.

Oil and gas platforms pose a hazard to commercial fishing and boating in general. Directional drilling from outside shipping lanes, however, can be used to develop tracts lying partially in shipping lanes.

An estimate of the importance of the impact of structures on the environment consists of two factors: (1) quantity - in this case, it is estimated that all tracts 5,000 acres or more in size will average two structures per tract, even though some tracts may never be developed, and (2) time - all structures will remain on site for an average

period of fifteen to twenty years. Structures also have positive impacts; they may serve as aids to navigation and rescue stations, and they attract fish, which, in turn attracts sport divers and sport fishermen.

The data below indicates how values were arrived at for the effect of structures on resources;

PROXIMITY SCALE (Structures) 1/

1.0 - Tract partially within shipping lane, anchorage area, natural resource system, activity or dumping area.

0.0 - Tract outside of shipping lane, anchorage area, natural resource system, activity or dumping area.

Tracts located in depths shallower than 27 meters are assigned a value of 1.0 due to their location in areas of intensive commercial fishing. Also, tracts located three miles or less from a known reef are assigned a value of 1.0.

b. Oil spills

The same two factors for estimating the importance of oil spills on the environment are as follows: (1) quantity - our analysis is based on all spills of 1,000 barrels or more, and (2) time - based on past experience, the oil itself may remain in contact with

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1/ Distances were taken from the edge of a tract to the nearest edge of the resource being affected.

or a hazard to, the environment for a period of one to ninety days.

A vector analysis consisting of near-shore current direction and velocity, and wind direction and velocity data in this region would be necessary to construct an oil spill simulation model. Unfortunately, reliable and extensive near-shore surface current data are not available for this region. However, observations for oil slicks indicate an average drift rate at approximately three percent of the surface wind speed in the direction of the wind. The three percent figure is an order-of-magnitude figure which, in our estimation, is more representative of the open ocean than are some of the values reported in the literature pertaining to confined bays or semi-enclosed waters. Therefore, this simple formulation will be applied to the extensive wind data available for the Gulf Coast of Louisiana for monthly wind patterns based on records dating back as far as 1881 for the purpose of estimating the shoreward rate of drift of an oil slick. A shoreward rate of drift is the single most important factor involved in estimating time and possible impact points of an oil spill on near-shore or onshore high value, vulnerable resources. This, in turn, will serve as a basis for assigning proximity values to each tract in terms of its relation to shore or high value, vulnerable resources.

It should be emphasized that the estimated direction and rate of oil slick movement is an approximation of the driving force exerted upon an oil slick by the wind. It does not consider slick geometries, natural dispersive forces, evaporation, absorption, dissolution or emulsification rates and other forces that could cause cessation of the spreading movement of a slick.

Wind rose data indicates that the critical months for a possible shoreward slick movement in this region would be March, April, May, June, and July. An oil slick in the New Orleans and Pensacola areas during these months would move at an estimated rate of 0.12 to 0.30 knots in the direction of the shore; (i.e., north by northwest), at a 30 - 35% frequency. An oil slick in the Pensacola area during these months would move at an estimated rate of 0.3 - 0.4 knots in the direction of shore at 35 - 45% frequency. An oil slick in the Galveston area during these same months would move at an estimated rate of 0.15 to 0.21 knots in the direction of the shore at a 35 - 40% frequency. The probability of an oil slick reaching shore is lower during the months of September, October, November, December, and January than it is during the spring and summer months.

For the purposes of analyses, we have established a proximity scale which is based on the following assumptions:

(1) An oil spill of 1,000 barrels or more has occurred.

(2) The rate of shoreward drift of an oil spill in the study area under normal conditions is estimated at

0.12 to 0.30 knots. For the purposes of this analysis, the 0.20 knot rate is used.

(3) The shoreward movement of an oil slick will occur more frequently in the spring and summer than in the fall and winter, but no distinction concerning the season will be included in the proximity scale. All tracts are considered to be in areas that could produce a shoreward drift of an oil slick at any given time should a spill occur. Although this would be least likely to occur with regard to tracts immediately seaward of the delta.

(4) A twelve-hour response time is necessary to implement contingency measures to stop or retard oil from reaching shore, or high-value, vulnerable resource areas. The oil industry presently has a contingency plan for containing and cleaning up oil spilled in federal areas of the OCS offshore in this region, which meets this response time capability.

Based on these assumptions, each tract is assigned a proximity number based on the following scale:

# PROXIMITY SCALE (Oil Spills)

| | | | |
|---|---|---|---|
| 1.0 - | Tract is within | 7.0 | statute miles of shore or significant resource. 1/ |
| 0.9 - | " " " | 7.1 - 8.0 | " " " " " " " |
| 0.8 - | " " " | 8.1 - 9.0 | " " " " " " " |
| 0.7 - | " " " | 9.1 - 11.0 | " " " " " " " |
| 0.6 - | " " " | 11.1 - 13.0 | " " " " " " " |
| 0.5 - | " " " | 13.1 - 16.0 | " " " " " " " |
| 0.4 - | " " " | 16.1 - 19.0 | " " " " " " " |
| 0.3 - | " " " | 19.1 - 23.0 | " " " " " " " |
| 0.2 - | " " " | 23.1 - 27.0 | " " " " " " " |
| 0.1 - | " " " | 27.1 - 32.0 | " " " " " " " |
| 0.0 - | " " " | 32.1 - up | " " " " " " " |

The proximity scale with regard to structures takes into account their potential impact on shipping and their location in relation to unexploded munitions dumping areas. This scale is different than that for oil spills, as shown above.

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1/ A line 12 miles seaward of the shoreline or outer islands, where appropriate, represents the point from which proximity of tracts to intensive commercial and sport fishing activities are measured (i.e., tracts within 19 miles of the shoreline are assigned a value of 1.0, those from 19.1 to 20.0 are assigned 0.9, etc.).

M. Recapitulation of the Proximity Evaluation

1. Refuges/Wildlife Management Areas

a. Oil Spills

| Proximity Value | Tract Number 1/ | Total Tracts |
|---|---|---|
| 1.0 | BS-71, S-66, MP-69 | 3 |
| .7 | EC-40 | 1 |
| .6 | MS2-75 | 1 |
| .5 | V-49, SMN-55-56, SS-67-68 | 5 |
| .4 | MS2-74 | 2 |
| .3 | V-50, MS1-73 | 2 |

b. Structures

Offshore structures will not have an impact on refuges or wildlife management areas.

1/ Tract designations in the proximity evaluation section are listed with an abbreviation for the lease area followed by the tract number. Appendix B lists the area abbreviations and Appendix A presents a detailed description of each tract.

2. Beach and Shorelines

a. Oil Spills

| Proximity Value | Tract Number | Total Tracts |
|---|---|---|
| 1.0 | S-66, MP-69, BS-71 | 3 |
| .9 | ST-65 | 1 |
| .7 | HI-9-10, EC-40, SS-67-68 | 5 |
| .6 | MS2-75 | 2 |
| .5 | HI-11, V-49 | 2 |
| .4 | MS2-74 | 1 |
| .3 | V-50, SMN-55-56, MS1-73 | 4 |
| .1 | T-103-107 | 5 |

b. Structures

Structures are not considered to have a impact on beaches and shorelines.

3. Intertidal Communities

a. Oil Spills

| Proximity Value | Tract Number | Total Tracts |
|---|---|---|
| 1.0 | S-66, MP-69, BS-71 | 3 |
| .9 | ST-65 | 1 |
| .7 | HI-9-10, EC-40, S-67-68 | 5 |
| .6 | MS2-75 | 1 |
| .5 | HI-11, V-49, SMN-55-56 | 4 |
| .4 | MS2-74 | 1 |
| .3 | V-50, MS1-73 | 2 |
| .1 | T-103-107 | 5 |

b. Structures

Structures will not impact the intertidal communities of the Gulf.

4. Reef Communities

a. Oil Spills

| Proximity Value | Tract Number | Total Tracts |
|---|---|---|
| 1.0 | HI-9-11, EC-40, V-50, VS-51, SMN-55-56, EI-57, EIS-61, MP-69, BS-71, PS1-76-80, TS-85-92, TS-94, T-95-98, T-102-116, TW-124, TW-127-128, TW-132 | 49 |
| .9 | EIS-60, S-66, MS1-73, TW-126, TW-131, TW-135 | 6 |
| .8 | V-49, EIS-59, TS-93, TW-130, TW-134 | 5 |
| .7 | EC-41, SI-65, TW-123, TW-125, TW-129, TW-133 | 6 |
| .6 | EC-42, EC-43, A-81 | 3 |
| .5 | SS-68, A-82-84, T-100-101, TW-118, TW-122, TW-120 | 9 |
| .4 | SS-67, MS2-74, TW-117, TW-119, TW-121 | 5 |
| .3 | T-99 | 1 |
| .2 | MS2-75 | 1 |

b. Structures

A total of 28 tracts (B-7, HES-25, 26, 29, 30, WC-35, WCS-37, ECS-47, VS-53, SMN-56, EIS-63, NO-72, PS1-77-80, TS-88, TS-92, T-95-96, T-102, T-104-107, T-113-115) have a proximity value of 1.0 for structures. These tracts are located three miles or less from a known reef.

5. Aesthetics

a. Oil Spills

| Proximity Value | Tract Number | Total Tracts |
|---|---|---|
| 1.0 | S-66 | 1 |
| .9 | MP-69 | 1 |
| .7 | EC-40, BS-71 | 2 |
| .6 | MS2-75 | 1 |
| .5 | V-49, ST-65 | 2 |
| .4 | SS-67, SS-68 | 2 |
| .3 | V-50, SMN-55-56, MS1-73 | 4 |

b. Structures

No tracts have a proximity value of 1.0 for aesthetic values.

6. Archaeology

a. Oil Spills

| Proximity Value | Tract Number | Total Tracts |
|---|---|---|
| 1.0 | HI-9-11, EC-40, V-49-50, SMN-55-56, EI-57, ST-65, SS-67-68, MP-69, BS-71, MS2-74-75, PS1-77-80, A-82, TS-86-89, TS-92, T-99-101, T-108-109, T-114-115 | 33 |
| .9 | S-66, A-84, TS-85, T-107 | 4 |
| .8 | VS-51, PS1-76, TS-91 | 3 |
| .7 | EC-42, EIS-60, A-81, A-83, TS-94, T-106 | 6 |
| .6 | EC-43, TS-90, T-102-105, TW-133-134 | 8 |
| .5 | EIS-59, EIS-61, TS-93, T-113, TW-130-132, TW-135 | 8 |
| .4 | TW-126-129 | 4 |
| .3 | T-111-112, TW-124-125 | 4 |
| .2 | T-110, T-116, T-123 | 3 |
| .1 | T-122 | 1 |

b. Structures

Four tracts (HI-11, WC-32, V-49, MSE-70) pose a high disruption potential to the archaeological resource.

7. Shipping

a. Oil Spills

| Proximity Value | Tract Number | Total Tracts |
|---|---|---|
| 1.0 | S-66-68, MP-69, BS-71, MS1-73-74, MS2-74-75 | 8 |
| .4 | EIS-61 | 1 |
| .3 | EIS-59-60 | 2 |

b. Structures

Seven tracts (MI-1-2, MAT-5, WCW-36, SS-67, MS2-74-75) have a proximity value of 1.0 for structures, indicating that some portion of these tracts are located within a shipping fairway.

8. Outdoor Recreation

a. Oil Spills

| Proximity Value | Tract Number | Total Tracts |
|---|---|---|
| 1.0 | S-66 | 1 |
| .9 | MP-69 | 1 |
| .7 | EC-40, BS-71 | 2 |
| .5 | V-49, ST-65 | 2 |
| .4 | SS-67-68, MS2-74-75 | 4 |
| .3 | V-50, SMN-55-56, MS1-73 | 4 |

b. Structures

No tracts have a proximity value of 1.0 for the recreation resource.

9. Commercial Fishing

a. Oil Spills

| Proximity Value | Tract Number | Total Tracts |
|---|---|---|
| 1.0 | HI-9-11, EC-40, V-50, VS-51, SMN-55-56, EI-57, EIS-61, MP-69, BS-71, MS2-74-75, PS1-76-80, TS-85-92, TS-94, T-95-98, T-102-116, TW-124, TW-127-128, TW-132 | 51 |
| .9 | EIS-60, S-66, MS1-73, TW-126, TW-131, TW-135 | 6 |
| .8 | V-49, EIS-59, TS-93, TW-130, TW-134 | 5 |
| .7 | EC-41, ST-65, TW-123, TW-125, TW-129, TW-133 | 6 |
| .6 | EC-42-43, A-81 | 3 |
| .5 | SS-68, A-82, AS-83-84, T-100, T-101, TW-118, TW-120, TW-122 | 9 |
| .4 | TW-117, TW-119, TW-121 | 3 |
| .3 | T-99 | 1 |
| .1 | SS-67 | 1 |

b. Structures

A total of 50 tracts (MAT-3-4, B-7-8, HI-9-11, HES 25, 26, 29, 30, WC-32-35, WCW-36-37, EC-40, ECS-47, V-49-50, VS-53, SMN-55-56, EIS-63, ST-65, S-66, MP-69, BS-71, NO-72, PS1-77-80, TS-88-92, TS-94, T-95-96, T-102, T-104-107, T-113-115) have a value of 1.0 for structures effecting commercial fishing. All of these tracts are located in water depths of 27 meters or less.

10. Sport Fishing

a. Oil Spills

| Proximity Value | Tract Number | Total Tracts |
|---|---|---|
| 1.0 | HI-9-11, EC-40, V-50, VS-51, SMN-55-56, EI-57, EIS-61, MP-69, BS-71, MS2-74-75, PS1-76-80, TS-85-92, T-94-98, T-102-116, TW-124, TW-127-128, TW-132 | 50 |
| .9 | EIS-60, S-66, TW-126, TW-131, TW-135 | 5 |
| .8 | V-49, EIS-58, TS-93, TW-130, TW-134 | 5 |
| .7 | EC-41, ST-65, TW-123, TW-125, TW-129, TW-133 | 6 |
| .6 | EC-42-43, A-81 | 3 |
| .5 | SS-68, A-82-84, T-100-101, TW-118, TW-120 | 8 |
| .4 | TW-117, TW-119, TW-121-122 | 4 |
| .3 | T-99 | 1 |
| .1 | SS-67 | 1 |

b. Structures

No impact to sport fishing is expected from structures.

11. Military Uses

a. Oil Spills

| Proximity Value | Tract Number | Total Tracts |
|---|---|---|
| 1.0 | PS1-77-79, A-81 | 4 |
| .9 | PS1-80, AS-93 | 2 |
| .8 | A-82 | 1 |
| .7 | AS-84 | 1 |

b. Structures

No structures are expected to result in any high disruption of any military activity should this sale proceed.

N. Summary Risk Analysis

All tracts proposed for leasing in this sale were evaluated according to the relative potential degree of hazard they posed to the resources and uses evaluated as they applied to the area. Although largely a subjective analysis, this evaluation is based on the detailed environmental analysis presented in previous sections of this statement, on our understanding of the industry's current technological capabilities, on the proximity evaluation in section N and on the proximity tables in Appendix B. The resources and uses with proximity values of less than 1.0 are presented only to indicate relative distance from the tracts. No provision is made to arbitrarily establish categories for these tracts.

Although the probability of a 1000 bbl. or more oil spill occurring from any tract is considered low (less than one per 1000 wells drilled), for purposes of analysis it is assumed that a 1000 bbl. oil spill has occurred from each tract and the slick is moving in the direction of the nearest resource area. In addition, although the probability that a structures will be erected on any tract leased is 1:3, we are assuming for this analysis that every tract offered will have a structure erected on it. Even though this will not occur, we make this assumption because there is no way of knowing which tracts will lease and which of those that are leased will eventually be the site for a fixed structure.

1. Relatively High Hazard Potential

All tracts with a value of 1.0 for the following categories are considered to have a high hazard potential: Refuge/Wildlife Management Areas, Beaches and Shorelines, Intertidal Communities and Reef Communities. A total of 54 tracts pose a threat from oil spills and/or structure placement which may damage reefs.

2. Relatively High Disruption Potential

The categories considered for this impact include the following: Archaeology, Outdoor Recreation, Commercial Fishing, Sport Fishing, Shipping and Military Uses. A proximity value of 1.0 are considered to constitute a high disruption potential. A total of 74 tracts pose threats from oil spills and structure placement.

3. Relatively High Aesthetic Degradation Potential

All tracts with a proximity value of 1.0 for oil spills and structures are considered to have a relatively high potential for degrading the aesthetic quality of the view from a particular shoreline. The severity of this impact will of course vary with the observer, the size and persistence of an oil spill and the distance from shore of the particular tract. A total of one tract applies to this particular impact.

4. Summary of Impact Potential by Tract

The following list summarizes all tracts which received a proximity value of 1.0 for a particular resource. In order to present

this in a clear manner the following designations were applied:

a. Relatively High Hazard Potential
b. Relatively High Disruption Potential
c. Relatively High Potential for Aesthetic Degradation

| Tract No.1/ | | Block No. | Tract No. | | Block No. | Tract No. | | Block No. |
|---|---|---|---|---|---|---|---|---|
| 1 | | 741 | 40 | a, b | 41 | 79 | a, b | N680 E124 |
| 2 | | 754 | 41 | | 218 | 80 | a, b | N680 E125 |
| 3 | b | 600 | 42 | | 219 | 81 | b | N665 E153 |
| 4 | b | 624 | 43 | | 220 | 82 | | N666 E154 |
| 5 | | 689 | 44 | | 233 | 83 | | N664 E153 |
| 6 | | A-16 | 45 | | 234 | 84 | | N664 E154 |
| 7 | a, b | 374 | 46 | | 235 | 85 | a, b | N644 E49 |
| 8 | a, b | 400 | 47 | b | 246 | 86 | a, b | N645 E49 |
| 9 | a, b | 31 | 48 | | 367 | 87 | a, b | N645 E50 |
| 10 | a, b | 33 | 49 | a, b | 61 | 88 | a, b | N646 E49 |
| 11 | a, b | 51 | 50 | a, b | 65 | 89 | a, b | N649 E55 |
| 12 | | A-500 | 51 | a, b | 261 | 90 | a, b | N650 E53 |
| 13 | | A-525 | 52 | | 375 | 91 | a, b | N650 E54 |
| 14 | | A-527 | 53 | b | 392 | 92 | a, b | N650 E55 |
| 15 | | A-538 | 54 | | 124 | 93 | | N651 E52 |
| 16 | | A-543 | 55 | a, b | 241 | 94 | b | N651 E53 |
| 17 | | A-551 | 56 | a, b | 242 | 95 | b | N624 E44 |
| 18 | | A-552 | 57 | a, b | 251 | 96 | b | N626 E45 |
| 19 | | A-574 | 58 | | 289 | 97 | | N627 E45 |
| 20 | | A-280 | 59 | | 337 | 98 | | N627 E46 |
| 21 | | A-287 | 60 | | 345 | 99 | | N633 E44 |
| 22 | | A-288 | 61 | a, b | 346 | 100 | | N634 E34 |
| 23 | | A-352 | 62 | | 350 | 101 | | N634 E45 |
| 24 | | A-361 | 63 | | 390 | 102 | a, b | N636 E55 |
| 25 | a, b | A-374 | 64 | a | 345 | 103 | a, b | N636 E56 |
| 26 | a, b | A-375 | 65 | b | 35 | 104 | a, b | N636 E57 |
| 27 | | A-379 | 66 | a, b, c | 6 | 105 | a, b | N637 E56 |
| 28 | | A-381 | 67 | b | 75 | 106 | a, b | N637 E57 |
| 29 | a, b | A-384 | 68 | b | 76 | 107 | a, b | N637 E58 |
| 30 | a, b | A-392 | 69 | a, b | 43 & 44 | 108 | a, b | N638 E43 |
| 31 | | A-395 | 70 | a, b | 304 | 109 | a, b | N638 E44 |
| 32 | a, b | 28 | 71 | a, b | 53 | 110 | a, b | N638 E52 |
| 33 | b | 37 | 72 | b | N641 E131 | 111 | a, b | N638 E53 |
| 34 | b | 193 | 73 | b | N686 E75 | 112 | a, b | N638 E54 |
| 35 | b | 226 | 74 | b | N660 E59 | 113 | a, b | N638 E55 |
| 36 | b | 342 | 75 | b | N661 E61 | 114 | a, b | N639 E43 |
| 37 | b | 583 | 76 | a, b | N677 E122 | 115 | a, b | N639 E44 |
| 38 | | 607 | 77 | a, b | N678 E125 | 116 | a, b | N539 E52 |
| 39 | | 631 | 78 | a, b | N679 E125 | 117 | | N621 E160 |

| Tract No. | | Block No. |
|---|---|---|
| 118 | | N621 E169 |
| 119 | | N622 E160 |
| 120 | | N622 E161 |
| 121 | | N623 E160 |
| 122 | | N623 E161 |
| 123 | | N626 E162 |
| 124 | a, b | N626 E163 |
| 125 | | N627 E162 |
| 126 | | N627 E163 |
| 127 | a, b | N627 E164 |
| 128 | a, b | N627 E165 |
| 129 | | N628 E162 |
| 130 | | N628 E163 |
| 131 | | N628 E164 |
| 132 | a, b | N628 E165 |
| 133 | | N629 E163 |
| 134 | | N629 E164 |
| 135 | | N629 E165 |

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1/ A detailed description of each tract is presented in Appendix A.